"People are just like particles, they behave in groups as if they were molecules in a test-tube."

Forbes Allan, *Milton's Progress*, 1999[1]

Copyrights:

The Human Molecule

LuLu, Inc.

The Human Molecule

All Rights Reserved © 2008 by Libb Thims

No part of this book may be reproduced or transmitted in any form or by any means, graphic, electronic, or mechanical, including photocopying, recording, taping, or by any information storage retrieval system, without the written permission of the copyright holder.

Publisher:
LuLu Enterprises, USA
860 Aviation Parkway, Suite 300, Morrisville, NC 27560
www.lulu.com

Libb Thims (books):
http://stores.lulu.com/libbthims

ISBN: 978-1-4357-1294-2 (paperback)

Printed in the United States of America

Contents:

> A structure becomes architecture and not sculpture when its elements no longer have their justification in nature.
>
> *Guillaume Apollinaire,* French poet

VI

Preface

1	WHAT IS A HUMAN: EARLY VIEWS?	1
2	PARETO'S 1896 HUMAN MOLECULES	17
3	ADAMS' 1910 HUMAN MOLECULES	21
4	TEILHARD'S 1936 HUMAN MOLECULES	23
5	DARWIN'S 1952 HUMAN MOLECULES	29
6	INTERMEDIATE VIEWS	31
7	ADVANCED INTELLIGENCE PERSPECTIVE	39
8	MODERN VIEWS	43
9	MOLECULAR EVOLUTION	69

References and Notes
Photo Credits
Index

Preface:

"Thank me no thankings,
nor proud me no prouds."
William Shakespeare, English writer

This short booklet is a focused piece on the definition of the human as a molecule. The need for such a book derives from the fact that the conception of a human being as a *human molecule* or dynamic twenty-six-element, substrate-attached, heat-driven, atomic structure, according to which the basic laws of chemistry, thermodynamics, and physics apply, is not yet a disseminated or discussed piece of basic knowledge, however simple and factual the definition may be and in spite of the fact that this elementary conception dates back to the 1869 views of French historian Hippolyte Taine.[1] The page-length is specifically kept to a minimum so to keep cost down, affordability up, and readability effective. The basic outline of the material found here stems from chapters two and five, 'The Human Molecule' and 'Molecular Evolution', respectively, in the 2007, 824-page, two-volume textbook *Human Chemistry*, but with the addition of new material on the pre-1950s views of the person as a molecule as well as the recently discovered April 2000 calculation of the twenty-two-element empirical molecular formula for the average human being by American limnologists Robert Sterner and James Elser.[2]

Libb Thims, Februrary 27, 2008

1 – What is a human: early views?

"The body of man has in itself blood, phlegm, yellow bile and black bile; these make up the nature of the body, and through these he feels pain or enjoys health."

Hippocrates, *Greek physician* – c. 460 BC

The human being is the most recognized shape on the planet. As of mid 2008, there were 6.7 billion of them existent on its surface a number that increases at a rate of 6.4 million per month.[1] Modern DNA evidence indicates that humans originated out of East Africa's rift valley about 150,000 years ago.[2] In between these two points, very little has been said about what exactly is a human and particularly what is a human from the viewpoint of atoms, chemistry, reactions, and evolution. In this view, according to current mass composition tables, a human being is a twenty-six element molecule that has evolved or reactively formed from hydrogen and helium atomic precursors over the last 13.7 billion years. The approximate molecular formula for the human being is shown below:[3]

$$C_{E27}H_{E27}O_{E27}N_{E26}P_{E25}S_{E24}Ca_{E25}K_{E24}Cl_{E24}Na_{E24}Mg_{E24}Fe_{E23}F_{E23}$$
$$Zn_{E22}Si_{E22}Cu_{E21}B_{E21}I_{E20}Sn_{E20}Mn_{E20}Se_{E20}Cr_{E20}Ni_{E20}Mo_{E19}Co_{E19}V_{E18}$$

In short, the human is a molecule. Whatever reasons one might have for denying this fact, they can hardly be expressed publically without leaving oneself open to the ridicule of children and feeble minds. In the new millennium, the implications of this basic human molecular definition will invariably bring about a revolution in human thought and philosophy.

This view, however, is not immediate. The earliest recorded views of what is a person conceived of humans as structures of clay, imbibed with the breath of life, formed from the primordial land mound that arose from the waters or chaos of beginning. This human clay logic derived from natural observations. In early third and fourth millennium BC civilizations situated around rivers such as the Nile, Tigris, or Euphrates, following the annual floods, which began after Sirius made its first heliacal rising of the year, new life could be observed to be born or begat from the ground: beetles from moist dung mounds, mice from riverbeds, and plants from the watered soil. In time, these natural reoccurring observations came to be incorporated into pre-scientific human creation myths. In Sumerian mythology,

4000 BC to 1750 BC, for instance, people were created by Nammu, the birth goddess of the watery depths, who molded clay collected by creatures called *sig-en-sig-du* and brought it to life to be a work force replacement for the gods in the maintenance of the land.[4]

In the first millennium BC, theories of what a human being was were becoming more scientific. In c. 490 BC, Greek philosopher Leucippus postulated the basic atomic theory, according to which all things in the universe, humans included, were composed of either atoms or voids. In c. 460 BC, the Greek Hippocrates, the father of medicine, had stated that humans, in part, were made of fire, in particular 'heat, a quantity which functions to animate, derives from an internal fire located in the left ventricle'. In addition, he held that held that all illnesses were the result of an imbalance in the body of the four humours, fluids that in health were naturally equal in proportion (*pepsis*), but that when the four humours, blood, black bile, yellow bile and phlegm, were not in balance (*dyscrasia*, meaning 'bad mixture'), a person would become sick and remain that way until the balance was somehow restored. In 350 BC, Greek philosopher Aristotle, in his *Physics*, stated that all earth-bound structures were comprised of four elements: fire, which is hot and dry, earth, which is cold and dry, air, which is hot and wet, and water, which is cold and wet.

In the centuries to follow, as science went into the dark ages, very little was said in regards to what a human was in the context of composition. In 1450, however, German goldsmith Johannes Guttenberg invented and built the printing press. This new information dissemination tool soon led to the scientific revolution.

Early in the scientific revolution, in 1492, Italian scientist and artist Leonardo da Vinci conceived of man as a 'geometrical figure' with two superimposed positions with his arms and legs apart and simultaneously inscribed in a circle and square, as shown on the cover. Leonardo based his drawing on some hints at correlations of ideal human proportions with geometry in Book III of the 25 BC treatise *De Architectura* by the Roman architect Marcus Vitruvius Pollio. The famous ideal human drawing later came to be known as the 'Vitruvian man'. Leonardo envisaged the Vitruvian Man as a *cosmografia del minor mondo* (cosmography of the microcosm), believing that the workings of the human body were analogous to the workings of the universe.[5]

Similar to da Vinci in logic was French philosopher René Descartes who set out to construct his own scientific system by studying himself and the world about him. One question Descartes posed to answer was could a human replica or human automaton (mechanical human) be constructed so exactly that an external observer would not be able to tell the difference between the real emotional human and the mechanical version. In his 1637 *Discourse on Method*, Descartes reasoned that if one, schooled in the study of mechanics, constructed a human automaton which 'walked, ate, breathed and, in a word imitated as much as possible all the other actions of (humans), including even the signs we use to express our passions, such as

crying when struck, fleeing when a loud noise is made near by, etc.' that another person 'would find it difficult to distinguish between real human beings and those who only had the same shape'.

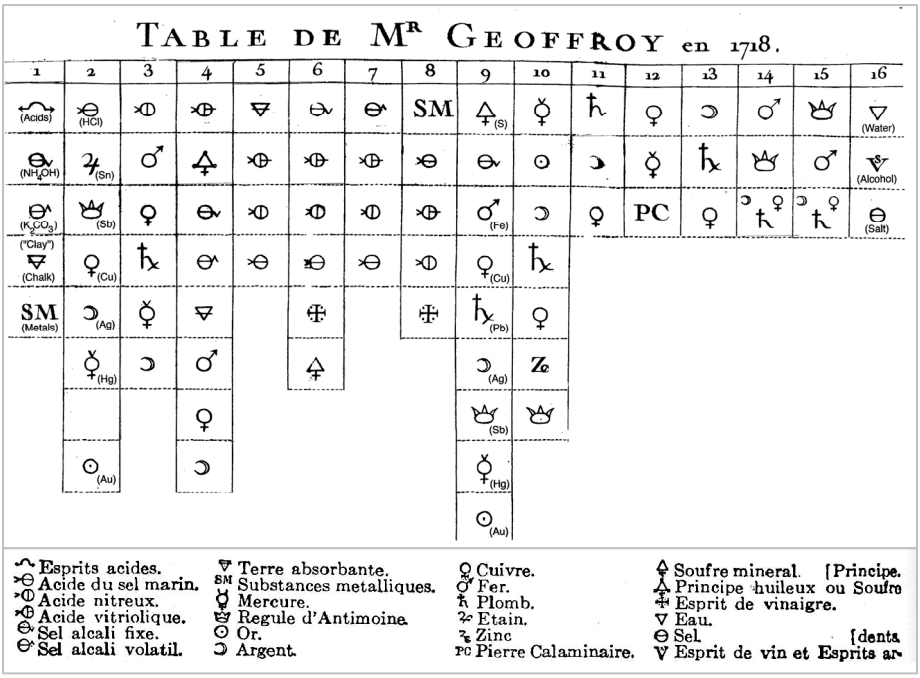
As a rule of thumb, according to Descartes, there would be only two ways to distinguish the real human from the mechanical ones. Firstly, an automaton could never 'arrange words in different ways to reply to the meaning of everything that is said in its presence'. Second, an automaton would never be able to 'act on the basis of knowledge, but merely as a disposition of their organs.' In short, an automaton could not react the way real humans could.

Another to take a mechanistic view of humans was English philosopher Thomas Hobbes. In his 1651 *Leviathan*, Hobbes postulated that motion was the natural state of all things, including people. All human sensations and emotions, he concluded, were the result of motion. He pictured humans as sophisticated mechanisms acted on by external forces; a sort of machine, consisting not only of the body, with its nerves, muscles, and sense organs, but also the mind, with its imagination, memory, and reason. The mind, however, according to Hobbes, was a pure calculating machine or mechanical device for adding and subtracting sensory inputs.[6]

In the midst of the scientific revolution was the chemical revolution. The beginnings of the chemical revolution centered around the revival of Leucippus' atomic theory through the works Descartes (1637), French mathematician Pierre Gassendi (1649), English chemist Robert Boyle (1661), and English physicist Isaac Newton (1686). In this revival, the concept of the 'molecule', from French word *molécule*, originating from the Modern Latin *molecula*, a diminutive of Latin word moles or 'mass', was born, generally defined as a small unit of mass or structure comprised of two or more atoms.[7]

Unique among this group was Newton, who conceived of molecules as being structures of atoms attached together by a chemical force of affinity. He outlined his atomic chemical force affinity bonding theory in the 'Queries' section to his *Opticks*. To cite one example of Newton's description of a gradient of affinity reactions, he states 'and is it not for want of an attractive virtue between the parts of water and oil, of quick-silver (Hg) and antimony (Sb), of lead (Pb) and iron (Fe), that these substances do not mix; and by a weak attraction, that quick-silver and copper (Cu) mix difficultly; and from a strong one, that quicksilver and tin (Sn), antimony and iron, water and salts, mix readily?'[8]

In 1718, during a translation into French of Newton's *Opticks*, French physician and chemist Étienne Geoffroy used Newton's descriptions of affinity reactions to construct the world's first affinity table, as shown below, containing twenty-four reacting species, detailing specifically what affinity reactions would occur between various combinations of reactants. This table seeded the chemical revolution:[9]



The origin of the concept of the 'chemical reaction' stems from this table through the work of Scottish physician and chemist William Cullen. In 1756, in lecture, Cullen utilized Geoffroy's affinity table wherein he pioneered the use of chemical reaction diagrams by using reaction arrows '→' and bonding brackets '{' to show the mechanistic steps in each elective affinity reaction.[10]

In Geoffroy's table, to elaborate, at the head of each column is a header species with which all species below can combine or have a rapport with. The latter are so placed such that any higher species replaces all others lower in the column from their compounds with that at the head of the table. In other words, the species at the head of the table can potentially react with any species below it. All the species below the header species are ranked by chemical affinity preferences relative to the top species, with a higher rank corresponding to a higher affinity tendency. The species at the bottom of each column, for instance, have the least amount of affinity for the header species. If the bottom species is in a weakly bonded relationship with the header species, any species above it can potentially displace it from its attached partner.

This table led to the development of the science of affinity chemistry and to the various laws of affinity; numbering up to ten, depending on which chemist was sourced. The best known is Plato's 'like attracts to like' affinity law, e.g. water-to-water or fire-to-fire, etc. The peak of the science of affinity chemistry culminated in the publication of the popular 1775 textbook *A Dissertation on Elective Attractions* by Swedish chemist Torbern Bergman. The center piece of Bergman's book, was a fifty-column, fifty-row, chemical affinity table, the largest ever assembled, showing

thousands of possible chemical reactions in schematic form between various chemical species, such as, for example, the famous 'double elective affinity' (double displacement reaction), where two chemical units, *AB* and *CD*, exchange or displace partners to form two new evolved species *AC* and *BD*.

$$AB + CD \rightarrow AC + BD$$

In the years to follow this publication, German polymath Johann von Goethe, known to have the world's highest IQ (210), used Bergman's textbook to conceive of people as reactive 'chemical species' (A, B, C, etc.) and couples and friendships as bonded unions (AB, CD, ABC, etc.) similar to those found on Geoffroy's affinity table, whose naturally precarious amorous affairs and friendships were governed by the affinity laws and the force of reaction as defined by Newton.[11] In short, according to Goethe, people were reactive chemical species whose free-will was determined by the force of elective affinity.[12] Goethe published his human chemistry theory in his 1809 novella *Elective Affinities*, a work that he considered his greatest.

Prior to this, to complicate matters, beginning in 1802 English chemist John Dalton began developing the modern theory of atomic combination, which can be summarized by five points: (a) elements are made of tiny particles called atoms, (b) all atoms of a given element are identical, (c) the atoms of a given element are different from those of any other element, (d) atoms of one element can combine with atoms of other elements to form compounds; a given compound always has the same relative numbers of types of atoms, and (e) atoms cannot be created, divided into smaller particles, nor destroyed in the chemical process; a chemical reaction simply changes the way atoms are grouped together. Soon thereafter, in 1808, Dalton published some of the earliest depictions of molecules or 'combined atoms'.

In the years to follow, the conception of the molecule began to flourish. In 1811, Italian physicist Amedeo Avogadro seeded the visual picture of the molecule in the public mind when he published his noted 'Essay on Determining the Relative Masses of the Elementary Molecules of Bodies', in which he outlined the basic definition of a molecule: 'the smallest particles of gases are not necessarily simple atoms, but are made up of a certain number of these atoms united by attraction to form a single *molecule*.' This logic, however, only functioned to compound the matter in regards to what a human was. In 1813, for instance, British chemist and physicist Humphry Davy compared man to a point atom.[13] Beyond this, over the next century, the metaphorical conception of the human molecule soon took root.

The first to coin the term 'human molecule' was French philosopher Hippolyte Taine. Taine's overarching goal in his work, being influenced by those as Hegel and Spinoza, was to apply the scientific method to the study of the humanities in a general desire to find a total explanation of the causal forces of life and the universe. In short, Taine believed that human nature could be explained by means of scientific

inquiry. In the introduction to his 1863 *Histoire de la littérature anglaise*, Taine outlined his general postulate that every reality, psychological, esthetic, or historical, can be reduced to a distinctly definable formula by discovering in each reality a single operative principle. The culmination of this general logic found its expression in Taine's central work, *De l'intelligence* (On Intelligence), completed in 1869.[14]

In the preface to this work, he states 'it is now admitted that the laws which rule formation, nutrition, locomotion, for bird or reptile, are but one example and application of more general laws which rule the formation, nutrition, locomotion, of every animal.' He continues 'in the same way we begin to admit that the laws which rule the development of religious conceptions, literary creations, scientific discoveries, in a nation, are only an application and example of laws that rule this same development at every moment and with all men.' In other terms, Taine states, 'the historian studies psychology in its application, and the psychologist studies history in its general forms.' On this logic, Taine reasons:

> He first notes and follows the general transformations presented by a certain *human molecule*, or a certain peculiar group of *human molecules*; and, to explain these transformations, he writes the psychology of the molecule or its group.
>
> — Hippolyte Taine, *French historian* [1869]

In sum to these preliminaries, Taine states 'for the last fifteen years I have contributed to these special psychologies' and that 'I now attempt a general psychology.' He notes, however, that 'to embrace this subject completely, this theory of the Intelligence (faculty of knowing) needs a theory of the will added to it.'

In 1871, similar in thinking to Taine, English biologist Thomas Huxley outlined the view that society as a whole is a 'social molecule' and that *social chemistry* is what is called politics. Specifically, in his article titled 'Administrative Nihilism', Huxley states:[15]

> The process of social organization appears to be comparable, not such much to the process of organic development, as to the synthesis of the chemist, by which *independent elements* are gradually built up into complex aggregations, in which each element retains an independent individuality, though held in subordination to the whole.
>
> — Thomas Huxley, *English biologist* [1871]

Huxley continues 'the atoms of carbon and hydrogen, oxygen, nitrogen, which enter into a complex molecule, do not lose powers originally inherent in them, when they unite to form that molecule, the properties of which express those forces of the whole aggregation which are not neutralized and balanced by one another. Each atom has given up something, in order that the *atomic society*, or molecule, may subsist.' Moreover, he points out, referring to someone who detaches in some way from society, 'as soon as any one or more of the atoms thus associated resumes the freedom which it has renounced, and follows some external attraction, the molecule is broken up, and all the peculiar properties which depended upon its constitution vanish.' To drive in his analogy, Huxley declares:

> "Every society, great or small, resembles … a complex molecule, in which the *atoms are* represented by *men*, possessed of all those multifarious attractions and repulsions which are manifested in their desires and volitions, the unlimited power of satisfying which we call freedom."

He continues, 'the *social molecule* exists in virtue of the renunciation of more or less of this freedom by every individual. It is decomposed, when the attraction of desire leads to the resumption of that freedom the expression of which is essential to the existence of the social molecule.' Moreover, Huxley reasons in a way that coins a new term, 'the great problem of *social chemistry* we call politics, is to discover what desires of mankind may be gratified, and what must be suppressed, if the highly complex compound, society, is to avoid decomposition.'[16]

In commentary on Huxley's proposal for the science of social chemistry, in which the sociologists are suggested to 'emulate and copy the chemists', author Werner Stark asks, in his 1962 book *The Fundamentals of Social Thought,* 'why should no social chemistry ever been developed?' He states that 'nobody would suggest that the social scientists should imitate meteorology, for this discipline does not appear to have got very far … but what about chemistry?' He states 'a sociology based on chemistry [has] in fact been called for, but, significantly, [this call has] found no echo.' Stark postulates, naively, that it would have been easy to take up the suggestion of Huxley and develop it further. He reasons further that 'an intending social chemist would have found it one whit more difficult to manufacture a sociological parallel to the Boyle-Charles law than Haret did to the Newtonian propositions. But the experiment appears never to have been tried.'[17] If Stark would have researched a little deeper, however, he would have found that this experiment was tried by Goethe and that it is not a simple matter of finding parallels.

Two others, during in the early 1870s, to have compared humans to atoms or molecules were Austrian physicist Ludwig von Boltzmann and Scottish physicist James Maxwell, two developers of the statistical and kinetic theories of gas particles, who coincidently had both recently read and been influenced by English Historian Henry Buckle's 1861 book *History of Civilization*.[18] In Buckle's *History*, he outlined the view that:

1. Owing partly to the want of ability in historians, and partly to the complexity of social phenomena, extremely little had as yet been done towards discovering the principles which govern the character and destiny of nations, or, in other words, towards establishing a science of history.
2. That, while the theological dogma of predestination is a barren hypothesis beyond the province of knowledge, and the metaphysical dogma of free will rests on an erroneous belief in the infallibility of consciousness, it is proved by science, and *especially by statistics*, that human actions are governed by laws as fixed and regular as those which rule in the physical world.
3. That the mental laws which regulate the progress of society cannot be discovered by the metaphysical method, that is, by the introspective study of the individual mind, but only by such a comprehensive survey of facts as will enable us to eliminate disturbances, that is, by the *method of averages*.
4. That human progress has been due, not to moral agencies, which are stationary, and which balance one another in such a manner that their influence is unfelt over any long period, but to intellectual activity, which has been constantly varying and advancing: "the actions of individuals are greatly affected by their moral feelings and passions; but these being antagonistic to the passions and feelings of other individuals, are balanced by them, so that their effect is, *in the great average* of human affairs, nowhere to be seen, and the total actions of mankind, considered as a whole, are left to be regulated by the total knowledge of which mankind is possessed".
5. That individual efforts are insignificant in the *great mass* of human affairs, and that great men, although they exist, and must "at present" be looked upon as disturbing forces, are merely the creatures of the age to which they belong.

Boltzmann, in turn, used this logic of the statistical averages of large systems of particles to frame his statistical thermodynamics of gas laws. In other words, Boltzmann drew analogies between his work on gas phase particles and the individuals in the social censuses that furnished Buckle's statistics. Boltzmann also was highly influenced by the 1859 publication of the *Origin of Species* by English

naturalist Charles Darwin. In particular, according to Dutch theoretical physicist S. R. de Groot, 'Boltzmann had a tremendous admiration for Darwin and he wished to extend Darwinism from biological to cultural evolution. In fact he considered biological and cultural evolution as one and the same things. ... In short, cultural evolution was a physical process taking place in the brain. Boltzmann included ethics in the ideas which developed in this fashion ...'[19] With this frame of mind, in his famous 1872 article 'Further Studies on the Thermal Equilibrium of Gas Molecules', Boltzmann concluded that:[20]

> "*Molecules are like to many individuals,* having the most various states of motion, and the properties of gases only remain unaltered because the number of these molecules which on average have a given state of motion is constant."
>
> — Ludwig Boltzmann, *Austrian physicist* [1872]

Maxwell also used the statistical average logic of Buckle in his gas theories. A few months after the publication of Buckle's great work, Maxwell wrote to his friend Lewis Campbell: 'one night I read 160-pages of Buckle's *History of Civilization*—a bumptious book, strong positivism, emancipation from exploded notions and that style of thing, but a great deal of actual original matter, the result of fertile study, and not mere brainspinning.'[20]

Soon thereafter, Maxwell began to apply Buckle's statistical sociology logic to the study of the problem of calculating the behavior of gases in which the particles are constantly engaging in collisions where the individual motions are extremely difficult follow. Specifically, in 1873 Maxwell directly compared statistical molecules in the gas phase to people as studied in Buckle's *History*:[21]

> "Those uniformities which we observe in our experiments with quantities of matter containing millions of molecules are uniformities of the same kind as those ... wondered at by Buckle."
>
> — James Maxwell, *Scottish physicist* [1873]

That same year, in his article 'Molecules' in the September issue of *Nature*, Maxwell states 'an atom is a body which cannot be cut in two; a *molecule* is the smallest possible portion of a particular substance.'[22] In addition, after speaking about the atomic theory of Democritus, Maxwell goes on to tell us that the word 'molecule' is a modern word. He states, 'it does not occur in *Johnson's Dictionary*. The ideas it embodies are those belonging to modern chemistry.' We are told that an 'atom' is a material point, invested and surrounded by potential forces and that when 'flying

molecules' strike against a solid body in constant succession it causes what is called pressure of air and other gases.

In terms of visualizing molecules, Maxwell states 'if we wish to form a mental representation of what is going on among the molecules in calm air, we cannot do better than observe a swarm of bees, when every individual bee is flying furiously, first in one direction, and then in another, while the swarm, as a whole, either remains at rest, or sails slowly through the air.'

He continues, 'as long as we have to deal with only two molecules, and have all the data given us, we can calculate the result of their encounter, but when we have to deal with millions of molecules, each of which has millions of encounters in a second, the complexity of the problem seems to shut out all hope of a legitimate solution.'

In further connection to Buckle's work, Maxwell states 'the modern atomists have therefore adopted a method which is I believe new in the department of mathematical physics, though it has long been in use in the (social) section of statistics', involved in census collections. He states, 'when the working members of *Section F* get hold of a *Report of the Census*, or any other document containing the numerical data of economic and social science, they begin by distributing the whole population into groups, according to age, income-tax, education, religious belief, or criminal convictions. The number of individuals is far too great to allow of their tracing the history of each separately, so that, in order to reduce their labor within human limits, they concentrate their attention on a small number of artificial groups. The varying number of individuals in each group, and not the varying state of each individual, is the primary datum from which they work.'

He continues 'this, of course, is not the only method of studying human nature. We may observe the conduct of individual men and compare it with that conduct which their previous character and their present circumstances, according to the best existing theory, would lead us to expect. Those who practice this method endeavor to improve their knowledge of the *elements* of human nature, in much the same way as an astronomer corrects the *elements* of a planet by comparing its actual position with that deduced from the received elements. The study of human nature by parents and schoolmasters, by historians and statesmen, is therefore to be distinguished from that carried on by registrars and tabulators, and by those statesmen who put their faith in figures. The one may be called the historical, and the other the statistical method.'

He concludes, 'the equations of dynamics completely express the laws of the historical method as applied to matter, but the application of these equations implies a perfect knowledge of all the data. But the smallest portion of matter which we can subject to experiment consists of millions of molecules, not one of which ever becomes individually sensible to us. We cannot, therefore, ascertain the actual motion of any one of these molecules, so that we are obliged to abandon the strict

historical method, and to adopt the statistical method of dealing with large groups of molecules.'

Another to have conceived the human molecule point of view was French sociologist and economist Léon Walras who, between 1858 and 1896, in efforts to establish a generalized economic theory of human equilibriums began to speak of people as 'economic molecules'.[23]

Walras' views derive from the beliefs of his father, French school administrator and amateur economist Auguste Walras. In 1858, one evening while the two were out walking, Auguste situated the postulate in Léon that to create a scientific theory of economics one would need to use differential calculus to derive a 'science of economic forces, analogous to the science of astronomical forces'.[24]

On this basis, Walras the younger soon became convinced that if the equations of differential calculus could capture the motion of the planets and atoms in the universe, then they should also be able to capture the motion of human minds in the economy.[25] In this mode of logic, Walras conceived the view of people as *economic molecules* and 'trades' of goods in economy as signs that the system was out of equilibrium. As goods are traded in a day, according to Walrus, people move from their initial less satisfied state to a more satisfied (happier) state, a point that Walras called the *general equilibrium* point.[25] This was the original seed of logic for the later development of equilibrium theories in modern economics.

In the years to follow, Walras developed an interest in both sociology and economics. In 1866, and over the next two years, Walras edited a journal called *Le Travail,* to which he contributed many valuable sociological articles. In 1870 he was appointed professor of political economy at Lausanne. His most important works are his 1877 *Elements of Pure Economics*, a mathematical treatment of economics, and the 1883 *Mathematical Theory of Social Riches*.[26]

In 1881, similar to Walras, Irish mathematical statistician and economist Francis Edgeworth published his *Mathematical Physics – an Essay on the Application of Mathematics to the Moral Sciences*, in which he set out to synthesize a theory of social mechanics similar to Newton's celestial mechanics. In this work, Edgeworth reasoned that the statistical mathematics of the 'world of atoms' may 'roughly illustrate the possibility of social mathematics.' Moreover, he postulates, 'the invisible energy of electricity is grasped by the marvelous methods of Lagrange; the invisible energy of pleasure may admit of a similar handling.' In this mode of logic, he began to glimpse economies that treated people like 'the multiety of atoms which constitute the foundations of the uniformity of physics'.[27]

In the 1891 book *Riddles of the Sphinx*, German-British philosopher Ferdinand Schiller outlined his philosophical views on sex and love in relation to social life, in which he considers people as atoms and bound sets of humans as molecules; specifically, he regarded a pair in love as a human molecule. He regarded sex in itself as 'a mark of imperfect individuality' for, as he states, 'neither men nor women

are sufficient for themselves or complete representatives, either physically or spiritually, of humanity.' Beyond this central ideal, he reasons also that sexual love, in itself, 'is not fitted to be the ideal of life because it cannot be made to include all existences', such as friends, function in society, etc.[28]

To make his point Schiller illuminates the view that people newly in love act out of a force that makes them, as a pair, antisocial. He states 'for it is undeniable that love in its higher developments is an anti-social force, and that its exclusive attraction contradicts the ideal of a universal harmony.' Moreover, Schiller reasons, 'whatever services this passion may have originally rendered in bringing men together, and forming the basis of social life, it is now antagonistic to the social ideal. A society of lovers would be a ludicrous impossibility; for it is the chief symptom of their condition that they are entirely wrapped up in each other, and that the rest of the world does not exist for them.' Furthermore, 'from the social point of view there is something awe-inspiring and terrible in the madness of a passion which teaches men to forget all other ties, the claims of country, friendship, duty, reason.'

On this logic, foreshadowing the basics of the theory of a human chemical bond, Schiller points out that 'this exclusiveness of the attraction which holds together the *human atoms* of the sexual dyad becomes particularly clear when we compare love with friendship; i.e. with the feelings which form the bond of the social union.' In contrast to the affinity of friendship, Schiller states:

> Love is distinguished from all other forms of affection by its exclusiveness; jealousy is part of its essence, and is the repulsion which will not brook the intrusion of any foreign force upon the intimate attraction of the *human molecule*.
>
> — Ferdinand Schiller, *German-British philosopher* [1891]

In the 1904 book *The English People: a Study of Their Political Psychology*, French political scientist Emile Boutmy used the term human molecule as a definition of the component of the masses to argue that equality of human molecules is the essential law of society and that royalty is a modern day anomaly on the decline. To uphold this anomaly, Boutmy argues that one particular disposition of the mind, peculiar to the English, is that their taste for philosophy is extremely rare and limited. He reasons that if they were to dig into the matter of the royal governance of their state of existence, they would see the un-naturalness of the situation.[29]

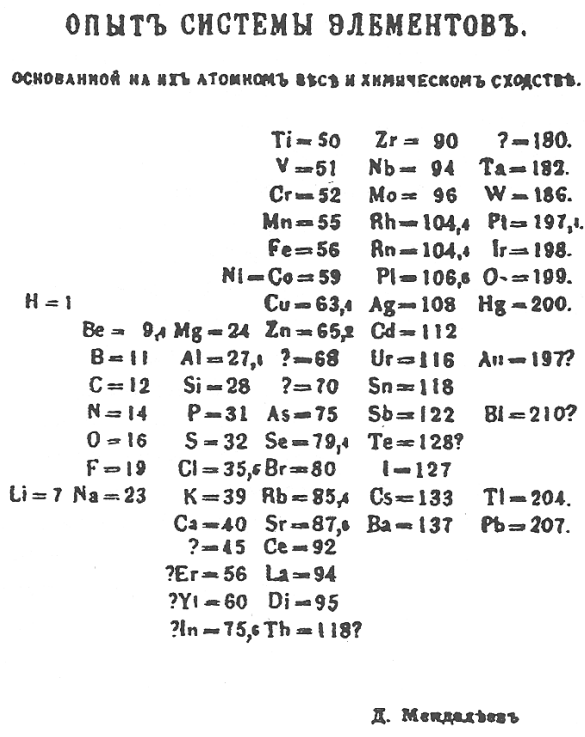
He states that 'peoples inspired by the true spirit of equality are those who, when confronted by the *varied elements* that go to make up a political nation, untiringly analyze and separate them, never satisfied until they have arrived at that simplest element of them all, the individual.' He continues, 'the intermediary groups and agglomerations left by history do not stop, hardly delay them; they press eagerly

forward.' In this mode of analysis, Boutmy reasons that 'only the individual is in accord with nature,' and that upon ultimate dissection of society:

> When the limit of the operation has been reached the *human molecule* stands alone, in its identity, among the millions of copies reproducing it.
>
> — Emile Boutmy, *French political scientist* [1904]

From this vantage point, Boutmy states that 'equality is the essential law of a society' and moreover 'it is perfectly evident that on so level a surface, there can be no place particularly designed by nature, and effectively sheltered, for the throne.' He concludes 'if royalty exists at all it appears isolated and exposed, there is nothing to proclaim its existence nor surround it with observances.'

In the midst of these various human atom-molecule theories, to note, more elements were being discovered and each element was being associated with a different type of atom. By 1818, Swedish chemist Jöns Berzelius had determined atomic weights for forty-five of the forty-nine accepted elements and in 1869 Russian chemist Dmitri Mendeleyev famously arranged the total 66-elements known at the time into a periodic table:



ОПЫТЪ СИСТЕМЫ ЭЛЕМЕНТОВЪ.

ОСНОВАННОЙ НА ИХЪ АТОМНОМЪ ВѢСѢ И ХИМИЧЕСКОМЪ СХОДСТВѢ.

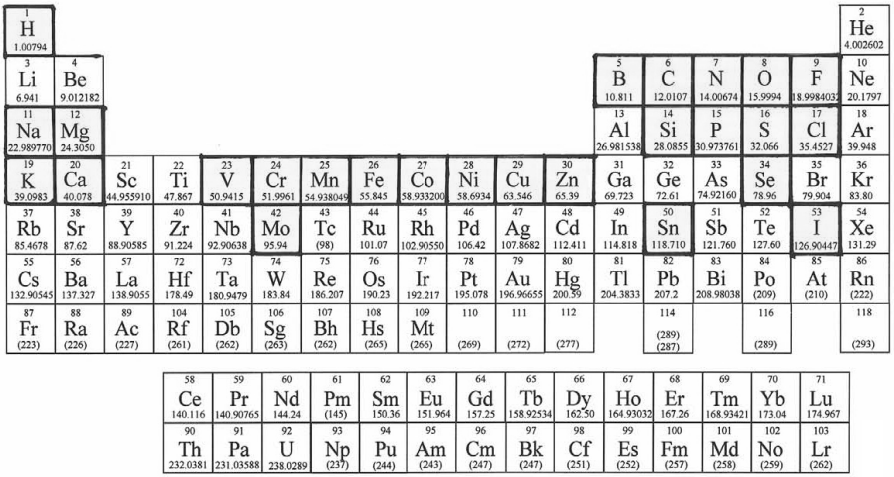
			Ti = 50	Zr = 90	? = 180.
			V = 51	Nb = 94	Ta = 182.
			Cr = 52	Mo = 96	W = 186.
			Mn = 55	Rh = 104,4	Pt = 197,1.
			Fe = 56	Ru = 104,4	Ir = 198.
			Ni = Co = 59	Pl = 106,6	O = 199.
H = 1			Cu = 63,4	Ag = 108	Hg = 200.
	Be = 9,4	Mg = 24	Zn = 65,2	Cd = 112	
	B = 11	Al = 27,1	? = 68	Ur = 116	Au = 197?
	C = 12	Si = 28	? = 70	Sn = 118	
	N = 14	P = 31	As = 75	Sb = 122	Bi = 210?
	O = 16	S = 32	Se = 79,4	Te = 128?	
	F = 19	Cl = 35,6	Br = 80	I = 127	
Li = 7	Na = 23	K = 39	Rb = 85,4	Cs = 133	Tl = 204.
		Ca = 40	Sr = 87,6	Ba = 137	Pb = 207.
		? = 45	Ce = 92		
		?Er = 56	La = 94		
		?Yt = 60	Di = 95		
		?In = 75,6	Th = 118?		

Д. Менделѣевъ

Mendeleyev's 1869 Periodic Table

Mendeleyev's table was unique in that elements were listed in order of atomic weights, such that their properties, e.g. bonding tendencies, chemical behaviors, physical states, etc., repeated in a series of periodic intervals.[30] The table also disclosed the locations of unknown elements yet to be discovered. By 1910, 81-chemical elements were known. It soon became apparent, in a slow gradualistic manner, that human beings were composed of variations of these elements. In modern terms, there are approximately 118 known elements, only 92 of which occur naturally, and only 26 of which have function in the human being. According to modern composition data, the following periodic table shows the functioning elements, shaded gray (in bold outline), found to comprise the human being:

Periodic Table of the Elements of a Human Being



In 1914, American engineer William Fairburn, in his short book *Human Chemistry*, postulated that each person is a *human chemical element*, that periodic table elements in some way have a relationship to different types of personalities, and that different human chemical reactions will result from different combinations of individuals.[31] In short, according to Fairburn:

> "All men are like *chemical elements* in a well-stocked laboratory, and the manager, foreman, or handler of men, in his daily work, may be considered as the chemist."
>
> — William Fairburn, *American engineer* [1914]

Fairburn argued that each person is a *human chemical* and that just as many laboratory chemicals are purified by fire, others by water, and still others by the influence of chemicals acting upon them, then so to would human chemicals become purified in the laboratory of life. Thus, according to Fairburn, there are some 'human

chemicals', i.e. people, that are developed by contact with other human chemicals, such that association with proper people will round those lives and infinitely increase their multifarious reaction possibilities and potentialities for usefulness. This encompasses the argument that associating in the wrong crowds produces wrong behaviors, whereas associating in the right or proper crowds produces right behaviors.

Fairburn argues that people should combine with society such that maximum personal efficiency and the greatest achievement results with a minimum amount of loss through unnecessary fatigue and 'wasteful reaction', such as those resulting from, what Fairburn classifies as friction and explosive interactions. Personal efficiency will be manifested, according to Fairburn, when people are positioned in reactions where their 'energies can be definitely and most economically directed toward the accomplishment of their work.'

Interestingly, according to Fairburn, people, like chemicals can be classified according to personal measures of *entropy*, an energy dissipation-like term defined in 1865 by German physicist Rudolf Clausius to quantify the portion of a system's energy *un*available to do useful external work.[32] In a loose sense, ordered molecules or chemicals have lower measures of entropy than less ordered ones. Shown below, for instance, are standard measures of entropy for four different molecules:

Species	Formula	S°(J/K·mol)
Methane(g)	CH_4	186.19
Acetylene(g)	C_2H_2	200.80
Ethylene(g)	C_2H_4	219.45
Ethane(g)	C_2H_6	229.49

Each human being or 'human molecule', in theory, can be assigned an entropy value similar to those shown in the table, a value which represents the measure of entropy of the present condition of the body with respect to a given initial condition. In modern terms, the conceptual understanding of what constitutes a human molecular entropy value, in terms of personality, social graces, character, occupation, wealth, possessions, information, education, knowledge, status, prestige, inner nature, values, ambition, etc., is a very advanced subject still in development.[33]

Fairburn also states that certain individuals may function as 'catalysts', facilitating other human chemical reactions, but not themselves being consumed, i.e. not taking part in the reaction. In chemistry, a *catalyst* is a substance whose presence affects the rate of reaction, but whose concentration itself is not changed.[34] Thus, Fairburn declares 'the success of the individual resulting from the proper application of his forces and the practical, satisfactory accomplishment of definite things in the work of life, leads to true happiness.'

In reference to the basic phenomenon of the *octet rule*, which states that atoms tend to be satisfied in their valencies when surrounded by eight electrons (generally, either four or six atoms), Fairburn reasons that just as 'no chemical element is in a state of harmony unless it is in contact with other elements or influences which do not antagonize or irritate,' that likewise, 'no human chemical can ever be truly happy in his work unless he is fitted by nature for the work which he is performing, and unless his general characteristics and temperament are in harmony with his specific duties and environment.'

Lastly, certain physical and mental heats, hot tempers, and explosiveness, such as wrath, argument, tension, friction, lack of harmony, chaos, etc., according to Fairburn, are wasteful human reaction components; an energy waste that can be quantified by measures of personal entropy. In these situations, 'the human chemicals are consumed, less progress is made toward the goal of achievement, power is lost, and harmony and good fellowship vanish.' Fairburn postulates, similar to Goethe, that just as there are affinities among the chemical elements, so are there associative bonding affinities among human chemical elements, which produce both favored and unfavored combinations of people and work groups.[35]

In 1919, American physician George Carey, in his popular book *Chemistry of Human Life*, declared 'there can be but *one law* of chemical operation in vegetable or animal organism: when man understands and cooperates with that life chemistry, he will have solved the problem of physical existence.' Furthermore, Carey discusses the *laws of chemical affinity*, which from Carey's viewpoint are responsible for the quantities of heat and work released from the human motor (person), and declares, dramatically, that:

> "Man's body is a chemical formula in operation."
>
> — George Carey, *American physician* [1919]

In these early years of the 20th century, not only was it beginning to become apparent that human beings were a type of chemical species or type of human molecule but some were beginning to not only view humans as molecules but social systems as thermodynamic systems of statistical assemblies of human molecules. The first to theorize in this direction was Vilfredo Pareto.

2 – Pareto's 1896 Human Molecules:

"Human behavior reveals uniformities which constitute natural laws … if these uniformities did not exist, then there would be neither social science nor political science, and even the study of history would largely be useless."

Vilfredo Pareto, *Italian social-economist*[1]

The first to define a person explicitly as a 'human molecule' and to further outline a sociological theory based on human molecular interactions was French-Italian mathematical engineer Vilfredo Pareto. Pareto was a disciple of French economist Léon Walras who had previously, as mentioned, begun to characterize people as 'economic molecules'. In 1893, having been schooled in Walras' economic theories, Pareto succeeded Walras in his chair as a professor of economics, at the University of Lausanne, Switzerland, and soon thereafter began to logically conceive of a human being as 'a kind of molecule'. Pareto argued that a rigorous economic theory would need to achieve a level of 'precision and certainty comparable to the propositions of the natural sciences such as chemistry, physics, etc.' To do this, as he states in his 1896 *Cours d'Economie Politique*:[2]

> "First we separate the study of ophelimity (economic satisfaction) from the diverse forms of utility, then we direct our attention to man himself; stripping him of a large number of his attributes, leaving out the passions, good or bad, reducing him to *a kind of molecule* that only acts in response to the forces of ophelimity."
>
> — Vilfredo Pareto, *French-Italian engineer* [1896]

Pareto's ambition, as outlined in his 1916 *Treatise on General Sociology,* was to construct a system of sociology analogous in its essential features to the generalized physico-chemical thermodynamics system as outlined in American mathematical physicist Willard Gibbs' 1876 *On the Equilibrium of Heterogeneous Substance*, the founding paper of chemical thermodynamics. A physico-chemical system, in general, is defined as an aggregate of individual chemical species. The factors characterizing the system are interdependent so that a change in one part of the system leads to adjustive changes in its other parts.

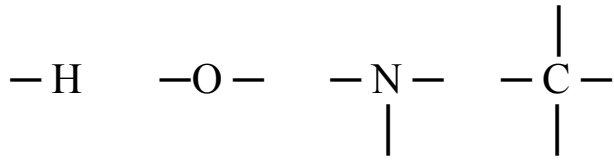
In Pareto's view, a society is 'a system of mutually interacting particles which move from one state of equilibrium to another'.[3] This was later translated, with the inclusion of Gibbs' thermodynamic models of physico-chemical systems in and out of equilibrium, to the effect that 'when a society suffers a disturbance, a reaction is set up which tends to bring it back to its original state.'[4] In chemistry, this effect is known as Le Chatelier's principle.

Subsequently, in Pareto's Gibbsian-sociology, the 'molecules' of the system are individuals with interests, drives, and sentiments 'analogous to the mixtures of chemical compounds found in nature.' The individuals of Pareto's social system, being considered as molecules, as he emphasized, are dynamic and heterogeneous.[5] In Pareto's discussion of wealth creation, for example, he states that 'the molecules of which the social aggregate is composed don't stay at rest; some individuals enrich themselves, others impoverish themselves.' Pareto's general sociology model sets forth the concept of a social system as a framework for analyzing mutually dependent variations among a number of variables determining human conduct. Specifically, according to Pareto:[6]

> "Society is a system of *human molecules* in a complex mutual relationship."

The individuality or heterogeneity of each human molecule, i.e. of each person, was a focal point of Pareto's theory, used to account for phenomenon such as hierarchies of wealth or the ills of society. In particular, according to Pareto, 'some affirm that all social ills come from alcoholism, others that they come from immoral literature and others, the greatest in number, accuse distribution of income.'[5] Here Pareto is referring to the fact that 80 percent of a system's wealth is typically confined to 20 percent of the population, a behavior known as the *Pareto principle* or 80-20 rule. He continues, 'they would go to absurd lengths to be able to discount the necessity of admitting that in the human species, as in all living species, individuals are not born equal, they have diverse characteristics and certain individuals are more suited to the environment in which they live.'[5]

In other words, just as atoms, such as hydrogen *H*, oxygen *O*, nitrogen *N*, and carbon *C*, of which human molecules have evolved from, have unique bonding, reactivity, and system work stability functions as determined by their inherent quantum electrodynamic structures (as depicted below):



then so to do human molecules (in their quantum electrodynamic *bonds*) and that this accounts for the division of wealth and work function desires and satieties in society.

Being influenced by the views of Walras, Pareto reasoned that a process similar to celestial mechanics governed social life. He suggested that social reality operated like a large social organic machine wherein individuals functioned as molecules in a predetermined systemic arrangement wherein each component has a discrete role, with the interrelations of the parts guided by the overall logic of the plan.[7]

In the 'social organism', according to Pareto, 'movements of an appreciable extent are taking place', which in this respect 'resembles a living organism'. In a living organism, he states, 'the circulation of the blood carries along certain molecules in rapid motion' and that 'the processes of assimilation and secretion are incessantly changing the molecules composing the tissue'.[8] In extrapolation, Pareto notes that 'the social system is much more complex', but that 'if we are to avoid serious errors in seeking to simplify it as much as possible, we must at least think of it as being composed of certain molecules, embodying residues, derivations, interests and inclinations, which, subject to numerous limitations, perform logical and non-logical actions.'[9]

At the social level, according to Pareto's sociological scheme, conceptions he labels as 'residues' and 'derivations' are the mechanisms by which society maintains its equilibrium. In particular, according to Pareto, 'individual human beings constitute the molecules of the social system, containing within themselves certain sentiments manifested by residues.' Society is seen as a system, 'a whole consisting of interdependent parts … the *material points or molecules* of the system ... are individuals who are affected by social forces which are marked by constant or common properties.'[10]

To elaborate, human action, according to Pareto, can be neatly reduced to *residue* and *derivation*. People act on the basis of non-logical sentiments (residues) and invent justifications for them afterwards (derivations). The derivation is the content and form of the ideology itself. But the residues are the real underlying problem, the particular cause of the squabbles that leads to the 'circulation of élites'. The underlying residue, he thought, was the only proper object of sociological enquiry.[11]

Residues are non-logical sentiments, rooted in the basic aspirations and drives of people. Pareto identifies six classes of residues, all of which are present but unevenly distributed across people; subsequently, the population is always a heterogeneous, differentiated mass of different psychic-types. The most important residues are Class I the 'instinct for combining' (innovation) and Class II, the 'persistence of aggregates' (conservation). Class I types rule by guile, and are calculating, materialistic and innovating. Class II types rule by force and are more bureaucratic, idealistic and conservative.[11]

Pareto's theory of society claimed that there was a tendency to return to a state of equilibrium where a balanced amount of Class I and Class II people are present in the governing élites. People are always entering and leaving the élite thereby tending to restore the natural balance. On occasion, when there is an imbalance, an élite will be replaced *en masse* by another. If there are too many Class I people in a governing élites, this means that violent, conservative Class II's are in the lower echelons, itching and capable of taking power when the Class I's begin to falter via cunning and corruption. If the governing élite is composed mostly of Class II types, then it will fall into a bureaucratic, inefficient and reactionary mess, easy prey for calculating upwardly-mobile Class I's (e.g. Tsarist Russia). Pareto regarded Napoleon III's France and the Italian 'Pluto-democratic' system as examples of *Class I heavy élite systems* and the Tsarist Russia as a *Class II heavy élite system*.[11]

In sum, through the chemical thermodynamic logic of Gibbs, Pareto argued that the methods of mathematics and the physical sciences can be carried over into the social sciences. In commentary on Pareto's sociology treatise, author Oliver Reiser, in his 1935 *Philosophy and the Concepts of Modern Science*, stated that 'one of the most interesting lines of thought directed towards formulating the fundamentals of a science of society' is Pareto's conception of 'human society as analogous to a system of molecules undergoing various combinations in space and time.'[12]

On this view, Reiser makes the point that 'some critics might like to raise the question of how it is that if we, as individuals, corresponding to the molecules of a gas we can know anything of the total state'. He continues, 'as constituents of a statistical ensemble we see what happens within the system, but only a super-observer could note from without those changing combinations which constitute the cultural patterns'. He concludes, 'the impossibility of such a human super-observer would seem to place a limitation upon the possibility of a science based on such assumption.'[12] Reiser makes a good point. He reasons that it is difficult to study a system that one is in. In general, however, his objections become negligible in light of modern chemical mechanism in which reactions can be mapped, movement by movement, bond change by bond change.

American biophysical chemist Lawrence Henderson, in his 1935 book *Pareto's General Sociology: A Physiologist's Interpretation*, gives a sound conclusion on Pareto's human molecular conception of society. He argues that in chemical thermodynamic terms, Pareto's 'social system contains individuals; they are roughly analogous to Gibbs' components. It is heterogeneous, compared to Gibbs' phases, for the individuals are of different families, trades, and professions; they are associated with different institutions and are members of different economic and social classes. As Gibbs considers temperature, pressure, and concentrations, so Pareto considers sentiments, or, strictly speaking, the manifestations of sentiments in words and deeds, verbal elaborations, and the economic interests.'[13]

3 – Adams' 1910 Human Molecules:

"Nothing in education is so astonishing as the amount of ignorance as it accumulates in the form of inert facts."

Henry Adams, *American Historian*

The second to conceive of a collection of human beings, in a clear manner, as a collection of molecules was American historian Henry Adams. In 1910, in his *Letter to American Teachers of History*, Adams defined the term 'human molecule' as the physicist's favorite particle and outlined the view that if the teaching of human history was to be considered a legitimate science it would need to incorporate the teachings of physics, particularly the first and second laws of thermodynamics.[1] In short, according to Adams, from the viewpoint of classical thermodynamics, which is the study of the relationship between heat and work in engines, humans must be considered as molecules.

Adams' letter was a bivalent discussion on paradoxical relationship between Irish physicist William Thomson's (Lord Kelvin's) 1852 take on the second law of thermodynamics as a universal tendency in nature towards the dissipation of mechanical energy and English naturalist Charles Darwin's 1859 take on evolution as a universal tendency towards the elevation of mental energy. Specifically, Adams reasoned that 'the laws of thermodynamics must embrace human history in its past as well as in its early phase' and that from the point of view of a physicist, to explain the fall of potential, as embodied in the first and second law of thermodynamics, in relation to 'Darwin's law of elevation', he must:

> "begin with his favorite figure of gaseous nebula, and may offer to treat primitive humanity as a volume of *human molecules* of unequal intensities, tending to dissipate energy, and to correct the loss by concentrating mankind into a single, dense like sun."
>
> — Henry Adams, *American Historian* [1910]

History, then, according to Adams, 'would then become a record of successive phases of contraction, divided by periods of explosion, tending always towards an ultimate equilibrium in the form of a volume of human molecules of equal intensity, without coordination.' In human chemical terms, Adams was attempting to reconcile the second law, i.e. that all natural systems are irreversible and tend to dissipate

energy in their work cycles, by postulating that human systems compensate or create new energy by the act of contraction of people in the formation of cities and world powers, similar to how the sun continuously releases energy by the gravitational contraction of its mass. In modern terms, Adams' human molecule social contraction theory can be interpreted through the dynamical release of energy in the formation, transformation, or dissolution of human chemical bonds.[2]

Adams' thermodynamic perspective of human life was a common one soon to be imitated by others in the century to follow. The reason for this is that at the heart of thermodynamics is the steam engine and inside of it, to produce work, a system of water molecules is alternatively put in contact with a hot body (a fire) and a cold body (a stream of cool water), a process according to which heat flows through the working body of water molecules, thus causing an expansion followed by a contraction of volume. These expansions and contractions are used to drive a piston up and down thereby producing external work. The laws that govern these processes also apply to human life and the production of work by people. Subsequently, when one begins to think about human life thermodynamically, a common trend is to arrive at the view that the human being technically is a molecule.

Adams' states, for instance, 'as a form of vital energy (man) is convicted of being a vertebrate, a mammal, a monodelphe, a primate, and must eternally, by his body, be subject to the second law of thermodynamics', which states that there is an irreversible energy loss in nature due to the working actions of system molecules acting on each other. Likewise, due to the universal authority of the thermodynamic laws, according to Adams, 'reason can be only another phase of the energy known as instinct or intuition; and if this be admitted as the stem-history of the mind as far back as the eocene lemur, it must be admitted for all forms of vital energy back to the vegetables and perhaps even to the crystals.' In the absence of any definite break in the series, of the human down to the smallest form, Adam reasons, 'all must me treated as endowed with energy equivalent to will.'

Adams conception of a human being as a molecule, to note, was not a solidified point of view in his mind. Earlier, for instance, he had sent a humorous letter to his brother Brooks stating that 'an atom is a man and that Clerk Maxwell's demon who runs the second law of thermodynamics ought to be made president.'[3]

In any event, the interpretation of humans as molecules by Adams was a bold step. In particular, it was not until 1926 that the existence of molecules was proven conclusive by French chemist Jean Perrin who received the Nobel Prize in physics for proving that molecules exist. He did this by calculating Avogadro's number, i.e. 6.022×10^{23}, the number of atoms in a twelve-gram sample of carbon-12, using three different methods, all involving liquid phase systems. First, he used a gamboge soap-like emulsion, second by doing experimental work on Brownian motion, and third by confirming Einstein's theory of particle rotation in the liquid phase.[4]

4 – Teilhard's 1936 Human Molecules:

"To have become conscious of our condition as *atoms patient of synthesis* … is to have attained a new vision of the general relationship which links matter to thought."

One of the most prolific users of the conception of the 'human molecule' was French philosopher Pierre Teilhard de Chardin who between 1916 and 1955 outlined an energy-matter theory on the dynamical relationship between evolution, from atom to man, and human consciousness, which he assumed to have a religious imperative. His theory described universal matter-energy evolution as a process that leads to increasing complexity, from pre-atoms, to atoms, to chemical systems, to mega-molecules, and to human molecules, culminating in the future unification of consciousness.[1]

Teilhard's interest in the evolutionary process began to seed at the age of ten when he was drawn to geology and mineralogy. In the years to follow, he focused on a mixture of philosophy, theology, and paleontology; later becoming a college teacher of chemistry and physics at the age of twenty-four. During this period, Teilhard was greatly influenced by French philosopher Henri Bergson's 1907 book *Creative Evolution*, which defined a type of evolution in which a free emergence of the individual intelligence could be recognized.

Subsequently, in the scheme of the universe, according to Teilhard, the case that interests us most is the problem of man. In particular, Teilhard states, 'the existence of an ascendant movement in the universe has been revealed to us by the study of paleontology'. In this trend, Teilhard asks 'where is man to be situated?

This ascendant movement, in cosmology, according to Teilhard, occurs in the direction of higher degrees of consciousness. Within this scheme, according to Teilhard, prior to Galileo, science thought of man as the mathematical and moral center of the world composed of spheres turning statically upon themselves. In the modern view, according to Teilhard, 'in terms of our modern neoanthropocentricity, man, both diminished and enlarged, becomes the head of a universe that is in the process of psychic transformation: man, the last-formed, most complex and most conscious of 'molecules'.' [2]

In his 1936 essay *L'Energie Humaine* (*Human Energy)*, a collection of ideas on the relations between morality, love, and the thermodynamics of evolution, Teilhard begins to define man as a 'human molecule' and to build theory on this perspective. He followed this up with the essay *Activation of Energy*, in which the concept of

'activation energy', defined as the minimal amount of collision energy required to initiate a reaction, is applied to human life to explain the evils of war and other philosophical issues, such as the origin of courage, fear, or peace of mind. The starting point in his essay is what he calls the problem of the 'plurality of man' meaning that humans are many and that 'with the particles from which are woven the bodies that surround us, number and mass are integral to man'. In particular, 'the molecular structure of mankind is a fundamental condition of our lives which we find in no way astonishing—we do not even notice it, so natural does it seem.'

Interestingly, in this essay, Teilhard was the first to give an estimate of the number of atoms in a human molecule. Starting with a description of the infinitely small (sub-atomic), where 'mass becomes fluid' and where all sorts of 'odd forces exist', he then moves on to detailed outline of how humans formed over millions of years. Teilhard states that from the 'dead' or 'living' reagents, complexity forms. First of all, he says, 'there is complexity in the sheer number of associated particles. In a single molecule of protein there is the equivalent of from 6,000 to 20,000 hydrogen atoms; this number rises to 68,000 in the hemoglobin of blood; to four million in the red pigment of the liver; and to seventeen and even twenty-five million in a virus particle.' He then marks a line in the sand by stating that 'no attempt has yet been made, I believe, to work out the number for a living cell, nor indeed would it be possible to do so, and there are about a thousand million million (10^{15}) in one human body.'[3] The modern count, to note, currently stands at 6.9×10^{27} atoms.[4]

Beyond this outline, Teilhard speaks of mechanism in the 'growing series of molecules'. In modern reaction terms, this can be visualized on molecular evolution tables.[5] In general evolution, according to Teilhard, there is a 'variety of assembled mechanisms'. Furthermore, in this process, beginning with 'chemical elements' and 'pre-living particles', he states 'the whole series of simple bodies gradually becomes involved and used in the building up of organic bodies.' At the lowest level, he states that these combinations are molecular and that in the formation of greater complexity, there is a *general mechanism* that ensures the actions of the functioning components as they fit together.[3]

In his 1941 *The Atomism of Spirit – an Attempt to Understand the Structure of the Stuff of the Universe*, similarly, Teilhard states that 'beneath the superstructure of mechanical and physiological links which evolution has progressively added to the elementary range of intra-cellular links, we do not immediately recognize in man the natural extension of the atom.'[6] Nevertheless, he states, 'once we have drawn the curve followed by a world which is advancing, along one of its axes, towards large complexes, it becomes clear (and dazzling clear) that in each one of us the same movement is being continued: however enriched it may be, it is still the same primordial movement from which, millions of years ago, there emerged the first elementary compounds of oxygen, nitrogen, and carbon.' In this context of 'universal moleculization', according Teilhard, 'man is precisely the most

elaborated, the youngest, and hence the most complex and most fully centered, of molecules'. This human molecular timeline, as we see, is the most accurate to date.

Having outline the basics of evolution from atom to man, Teilhard then states that the immediate issue is to 'scientifically formulate the problem of the future', whereby, given the known atomic trend in development or what he calls the 'internal law of development', we now wish to know what we are going to become, and that to find this all we have to do is to extend the law.

Interestingly, in conceiving of the development of complexity in the evolution from atom to human molecules as a continuous lineage, Teilhard correctly confronts the perceptual issue of life vs. non-life or animate vs. in-animate. In particular, he states 'apart from accepting the false evidence that there are in the universe two irreducible forms of matter (animate and inanimate), I know and feel that no more obstinate illusion persists in our minds than that of a complete difference between what prepared us and what we now are.' Moreover, he continues, 'if we really observe the still extreme absence of organization, and hence of potential organization, in which the *thinking portion of the earth* is restlessly in movement here and now, we have no justification for the belief that the moleculization of matter has reached its ceiling in us.'

Teilhard reasons that, given scientific evidence in the case for the development of consciousness, from atom to man, the 'cosmos is still continuing its arduous drift towards increasing states of complexity: of centration, in consequence, and, as a further consequence, of consciousness.' He postulates that an informed eye might be able to detect this future developmental trend about us. In the case of looking at '*human molecules* in isolation,' Teilhard states, 'no positive result emerges' because, as he says, within the last twenty thousand years there appears to have been no appreciable change either in the structure or in the functioning of the brain. What is changing, according to Teilhard, however, is the 'multiplication of inter-connections of all kinds' (human chemical bonds) between the human molecules and the amazing speeding-up of their development.

In particular, with the growth of these human molecular connections, according to Teilhard, humankind is becoming less and less materially self-sufficient. He states that it is 'no longer possible for us to live and develop without an increasing supply of rubber, of metals, oil, electricity and energy of all sorts' and that 'no individual could henceforth manage to produce his daily bread on his own.' Subsequently, 'mankind is more and more taking the form of an organism that possesses a physiology and, in the current phrase, a common metabolism.'

In his 1947 essay 'The Formation of the Noosphere', he outlines the generalized view that 'no one can deny that a (world) network of economic and psychic affiliations is being woven at ever increasing speed which envelops and constantly penetrates more deeply within each one of us. With every day that passes it becomes

a little more impossible for us to act or think otherwise than collectively.' In relation to the individual person, he concludes:[7]

> the scope of each *human molecule*, in terms of movement, information and influence, is becoming rapidly coextensive with the whole surface of the globe.
>
> — Pierre Teilhard, *French philosopher* [1947]

In other words, according to Teilhard, human molecules are forming a connective mental sheath around the globe. Teilhard calls this connective sphere of human consciousness and mental activity the 'noosphere'. As he writes this during the period of the Second World War, he states that the 'present world is still dominated by the forces of hatred and repulsion', but that, reasoning optimistically, he posits that in the near future, human mental attachments will generate a 'a state of active sympathy, in which each separate *human element*, breaking out of its insulated state under the impulse of the high tensions generated in the noosphere, will emerge into a field of prodigious affinities.' For, he continues, in a bold statement that outlines the basic logic of the human chemical bond:[8]

> If the power of attraction between simple atoms is so great, what may we not expect if similar bonds are contracted between *human molecules*?

Along these lines, 'humanity', he states, 'is building its composite brain beneath our eyes.' On this basis, Teilhard reasons that 'may it not be that tomorrow, through the logical and biological deepening of the movement drawing it together, it will find its heart, without which the ultimate wholeness of its powers of unification can never be fully achieved? To put it in other words, must not the constructive developments now taking place within the noosphere, in the realm of sight and reason, necessarily also penetrate to the sphere of feeling?'

In his *A Sketch of a Personalistic Universe,* Teilhard states 'there is neither spirit nor matter in the world; the stuff of the universe is *spirit-matter*. No other substance but this could produce the *human molecule*.' He continues, 'I know very well that this idea of spirit-matter is regarded as a hybrid monster, a verbal exorcism of a duality which remains unresolved in its terms. But I remain convinced that the objections made to it arise from the mere fact that few people can make up their minds to abandon an old point of view and take the risk of a new idea ... biologists or philosophers cannot conceive a biosphere or noosphere because they are unwilling to abandon a certain narrow conception of individuality. Nevertheless, the step must be taken. For in fact, pure spirituality is as unconceivable as pure materiality. Just as, in a sense, there is no geometrical point, but as many structurally different points as

there are methods of deriving them from different figures, so every spirit derives its reality and nature from a particular type of universal synthesis.'

In sum, Teilhard's objective was to assemble views on the relationship between energy, spirituality, consciousness, irreversibility, thermodynamics, and the direction of evolution. The only factor in his theory that seemed to bias his logic was his presupposed mandate of spiritual substance inherent in the atoms and molecules. In other words, according to Teilhard's beliefs, if the human being possesses a type of spirituality, and if human beings evolved, in a discontinuous lineage, from atoms and sub-atomic particles, then logically all must entities in the universe must possess a type of matter-energy spirituality. Subsequently, in many instances, Teilhard would side with gospel logic over that of scientific phenomenon.

In the case of the future of man, for instance, Teilhard reasons that the 'gospel formula' of *love thy neighbor* outweighed fossil and geological findings from his work as a paleontologist and geologist indicating that species tend to diverge, over time, through actions of inter-group hatreds or revulsions, i.e. chemical repulsions, in the separations of individuals and communities as new species are formed, and that conversely in the future, humankind would set their differences aside so to converge into one large bonded community—the 'noosphere'.

In any event, in his logic Teilhard developed the evolutionary perspective of the person as a 'human molecule', which he considered as an evolved structure of atoms. His generalized theory then, being biased by a presupposed religious mandate in the structure of the universe, was to draw up the main lines of a spiritual energetics that he defined as 'psychodynamics, on the analogy of thermodynamics' or a 'motor force in the universe', devoted to the study of 'the conditions under which the human zest for auto-evolution and ultra-evolution occurs' in relationship to dissipation, i.e. entropic irreversibility.[3]

One of more interesting aspects of Teilhard's theories is his ability to illuminate some of the more ultimate questions of life faced with when one adopts the human molecular perspective. In particular, according to Teilhard, once a person leaves the 'individualistic of the monad and resolutely adopts, in judgment and action, the point of view of the atom', the issues of function or purpose in relation to a philosophy of life come into question. As mentality evolves, in its perception of the overall functioning of the universe, from the atom, to the small molecule, to biological molecules, to the modern cosmopolitan human molecule, as Teilhard states, 'man experiences an exactly proportionate increase in his need to find a tangible objective for his activities'.[6] He continues, 'why, he asks, are we born in chains, bound to the fetters of toil? Why do we have to search ever further afield? Why slave away in our quest? Why continue to build? Why even continue to reproduce our kind?'

In summarizing these puzzles, he states 'a man does not need to have lived very long to realize how insistently this question confronts even the most humble folk, how it affects more and more of us, so that it is now becoming acute.' He continues,

'the agony of being alive is increasing in intensity in us, given new force and super-stimulated by recent revelation we have been given of time and space.' In other words, in Teilhard's view, the older pre 17th century systems of meaning, morality, and purpose of life are being called into question when confronted with the modern human molecular view of life as atomic structures in the vast evolving universe.

In 1952, Teilhard stumbled upon a copy of the newly published book *The Next Million Years*, by English physicist Charles Galton Darwin, who also coincidently utilized a 'human molecule' perspective, as discussed in the following chapter, in which thermodynamics, the science of energetics, was used to outline humankind's future in the coming million years. This stimulated Teilhard, the following year, to write a short essay titled 'The Energy of Evolution' in relation to activation energy.[9]

In second section of his essay, titled 'Action and Activation, or, on the Dynamic Role of Foresight in the New Evolution', Teilhard gives an excellent definition of *life*, where he states that 'one of the most distinctive characteristics of living substance in action is undoubtedly the predominate importance assumed in it by the fact of being (or of not being) appropriately *responsive to a stimulus* and *stimulated*.' Moreover, in terms of energy measurements involved in the chemical reactions between human molecules, as Teilhard clearly points out, these stimulations are very difficult to conceptualize, let alone to quantify. He states 'theoretically, the physicist may well be able to calculate (in calories, for example) the quantity of energy that can usefully be employed by an animal at a given moment. But what quantity of this store of energy is going, in each case, to be effectively released—and in what direction—and at what speed?' He concludes 'that is something we cannot determine without introducing a whole series of imponderables which are tied up with the phychism of the individual in question.'

As a general rule, Teilhard postulates that 'in order to fully express the dynamic state of living matter, we must use a formula that includes at least two terms: the first measuring in figures a certain thermodynamic magnitude, and the second expressing a certain capacity given to this energy of expending itself, more rapidly or less rapidly, in the direction of survival, of multiplication, or of some super-arrangement of organic matter'. The second term he designates as *activation*, something he says will likely be neglected by the bio-energetic specialists. Curiously, he reasons, the general process of activation of living matter, especially in human molecules, is harnessed by 'forces that stem from the future' characterized by an 'increasing predominance of the effects of fear or hope allied to the formidable gift of foresight.' Teilhard reasons that in this latter point 'can certainly be found the ultimate driving force of the mechanism of evolution.'[9]

5 – Darwin's 1952 Human Molecules:

"I have just finished my sketch of my species theory. If as I believe that my theory is true and if it be accepted even by one competent judge, it will be a considerable step in science."

Charles Robert Darwin, *English naturalist*[1]

The second recorded use of the term 'human molecule', interestingly, was made by English physicist Charles Galton Darwin, the grandson of Charles Darwin, in his 1952 book *The Next Million Years*.[2] The purpose of this book, as he states, is to reasonably predict the history of the world and particularly human kind for the next million years. As to his educational qualifications to justify the writing of such a lofty book, he states that although he makes no claim to being a historian, he has always had a great interest in history and in the biological sciences, and that the final stimulus to write his ideas came from the physical sciences.

To begin his historical argument, he cites Isaac Newton's enunciation of the law of universal gravitation, which enables the astronomers to predict exactly where any planet will appear in the sky at any give future date. He also cites the invention of the television, in which, as he states, electrical engineers are able to use the electromagnetic laws to channel currents and to direct signals to and from antennas so to produce a visual image. To predict the future of human life he turns to the principle of probability as found in the laws of statistical thermodynamics.[3]

With the statistical laws, according to Darwin, we are able to work out the details of what happens when two molecules collide, whereas for larger systems of molecules we use the ideal gas laws, such as Boyle's law, which relates pressure to volume, to predict their behavior. To derive Boyle's law, according to Darwin, all that is required is the knowledge that the molecules constitute what is technically called a *conservative dynamical system*, a phraseology that stems from American mathematical physicist Willard Gibbs' 1901 *Statistical Mechanics – the Rational Foundation of Thermodynamics*. This name, as Darwin states, is derived from the fact that the total energy of two colliding molecules is conserved. In other words, in the reactive system, the total internal energy stays constant during the collision.

Next, Darwin states that, in addition to internal nature of the dynamical system of molecules, which depends on the conservative nature of the interactions, there are also external conditions, such as pressure and volume, which must be accounted for. To determine these, he states that scientists measure factors such as the size of containing vessel and the force with which the molecule push on the walls of the

containing vessel. According to this logic, Darwin reasons that if predictions are to be made of the kind yielded by the methods of statistical mechanics, then it will be necessary to consider both internal and external conditions.

With this logic of molecular statistical mechanics as a basis, Darwin argues that this methodology will allow one 'to foresee the general character of the future of the history of mankind'; and states that:

> We may, so to speak, reasonably hope to find the Boyle's law which controls the behavior of those very *complicated molecules*, the members of the human race, and from this we should be able to predict something of man's future.
>
> Charles Galton Darwin, *Physicist* [1952]

Darwin reasons that to find these laws, we must determine the internal condition of the conservative dynamical interactions and the external conditions analogous to the walls of the containing vessel. If these demands can be satisfied, according to Darwin, then 'there is a prospect that a great deal can be foretold of the future of the human race, and this without any very close detail in the basic principles from which it is derived.'

In the system of gas molecules, the external conditions are determined by the constraints of the containing vessel; the analogy for humans, according to Darwin, is that the earth itself is the containing vessel. Similarly, the internal conditions of human reaction systems, which are analogous to the property of being conservative dynamical systems, lies, as Darwin says, 'of course much deeper'. In particular, according to Darwin:

> The conditions internal to the system must depend upon the laws governing the nature and behavior of the *human molecules*.

He continues 'the reader may feel that this is a bad analogy, because unlike a molecule, a man has a free will, which makes his actions unpredictable.'

In a modern sense, we know that Darwin is wrong on this latter point, i.e. man absolutely does not have a free will. This latter point will be explained more as we progress. The long and the short of this explanation, however, is that if one believes that one type of molecule has a free will than one must prove that all molecules have a free will, which is an argument in absurdity.[4] Nevertheless, Darwin justifies this, humorously, by stating that the 'the individual collisions of the human molecules may be a little less predictable than those of the gas molecules.'

6 – Intermediate Views:

"The meeting of two personalities is like the contact of two chemical substances; if there is any reaction, both are transformed."

Carl Jung, *Swiss psychologist*

The conception of a human as a molecule was not immediate. During the remainder of the 20th century, a number of intermediate views emerged. In 1946, American social historian Lewis Mumford, in commentary on Hobbes' *Leviathan*, which reasoned that people, being governed by the laws physics, sought to accumulate power up to a personal level of satiety that varies among individuals, stated that such a view reduces the individual to '*an atom of power*, ruthlessly seeking whatever power can command.'[1]

In 1953, American economic historian Robert Heilbroner, in his popular book *The Worldly Philosophers: the Lives, Times, and Ideas of the Great Economic Thinkers*, the second highest-selling economics book of all time, reasoned that 'economics, after all, does concern the actions of aggregates of people, and *human aggregates*, like aggregates of atoms, do tend to display statistical regularities and laws of probability.'[2] Moreover, he states 'as the professoriate turned its eyes to the exploration of the idea of *equilibrium*—the state towards which the market would tend as a result of the random collisions of individuals all seeking to maximize their utilities—it did in fact elucidate some tendencies of the social universe.'

Heilbroner, however, was off-logic on many points. In commentary on the early 20th century economist's use of analogies from the atomistic-molecular statistical mechanics of Maxwell and Boltzmann and the equilibrium criterion of Gibbs, for instance, Heilbroner declares illogically that 'there is an unbridgeable gab between the behavior of [particles] and those of human beings who constitute the objects of study of social science.' He continues, 'aside from pure physical reflexes, human behavior cannot be understood without the concept of volition—the unpredictable capacity to change our minds up to the very last minute.' By way of contrast, he reasons, 'the elements of nature behave as they do for reasons of which we know only one thing: the particles of physics do not choose to behave as they do.'[2]

In modern terms, however, we know that Heilbroner is wrong in his argument: humans behave as molecules behave. The volition of any and all molecules is chemical mechanism and reaction, phenomenon operated by the fundamental forces, the electromagnetic and gravitational forces predominately. There are some, to note, that even in current age will argue the opposite. In the 2004 book *Critical Mass* –

How One Thing Leads to Another, in which a theory of human particle social physics of interactions is loosely outlined, English chemist and physicist Philip Ball states, in comment on Heilbroner's volition argument, that 'Heilbroner is, of course, right to say that humans make choices whereas particles do not.' The fact that a modern chemist-physicist does not see the deeper picture of human operation leads one to the conclusion that very few people in modern times understand their own existence.

During these years, another to have conceived of an intricate type of social atom theory was Romanian-born American group psychotherapist Jacob Moreno. In the early 1900s, Moreno began to develop his interest or rather curiosity in psychology by observing and joining in children's play in the gardens of Vienna, Austria. At the time, he was a student of philosophy and mathematics and had not yet entered into medical school. In his observations, according to his wife Zerka, 'he was impressed by the great amount of spontaneity in children and became aware that human beings become less spontaneous as they age'.[3] The question he asked himself was why does this occur?

This question stuck with him in the following years, and later stimulated him to develop a theory of interaction spontaneity in group settings. In a partial solution, developed during his years as a medical student at the University of Vienna, which he completed in 1917, he began to reject the many of the points of Freudian theory, such as conceiving of the mind in isolation or as analyzing people in isolation in an office, and instead sought to develop a dynamic-evolving social structure theory based on energy psychological interactions in group settings. Soon thereafter, he developed the conception of *sociometry*, a quantitative method for measuring social relationships, a term he derived from the Latin *socius* meaning companion, and *metrum* meaning measure. He defined sociometry as 'the inquiry into the evolution and organization of groups and the position of individuals within them.' In particular, 'as the science of group organization, it attacks the problem not from the outer structure of the group, the group surface, but from the inner structure.' Moreover, 'sociometric explorations reveal the hidden structures that give a group its form: the alliances, the subgroups, the hidden beliefs, the forbidden agenda's, the ideological agreements, the 'stars' of the show, etc.'

In 1951, building on these views, Moreno outlined a *social atom theory* in which, using a crude structure of the physical atom in gases, fluids, and solids as a basic metaphorical model of social structure and group interaction, he defined the *social atom* as a four-level hierarchical structure, with the individual at its center, comprised of the *acquaintanceship atom* (all the people of whom one is aware), the *collective atom* (groups to which the person belongs), the *individual atom* (loosely, one's close friends), and the *psychological atom* (those persons essential to one's psychological well-being).[4] In modern terms, we might think of Moreno's model as a social matrix of people bonded into, simultaneously, levels of weak, intermediate, and strong relationships, in a three-dimensional psychological structure.

In overview, according to American Morenean psychologist Rory Remer, Moreno's social atom theory reasons that 'as social beings, we have numerous patterns of connections with others', and that in Morenean theory, 'we cannot successfully function, or even exist, without some minimum number of certain types of such connections.' He states that 'this phenomenon is addressed through our social atom.' Not all people, as Remer points out, are equally bonded to us. Different qualitative and quantitative levels of connection, as we perceive them, exist. Those present in our lives populate these structures, of our social atom. Thus, according to Morenean logic, although these constellations have a more or less consistent pattern, they still fluctuate, where people come and go, becoming more or less important in our lives, varying from fleeting contacts to deep abiding relationships.[5]

In using physics models, Moreno borrowed the conception of electrons moving up or down in atomic orbital levels via the absorption or release energy, respectively, to argue that human social atoms (acquaintances) move up or down in one's personalized social levels. In particular, Moreno postulated that the reasons a person belongs to a certain level or changes from one level to another can be explained in terms of shared warm-ups, telic bonds, or role reciprocities.[6] Interestingly, Moreno even suggested that the pair-bond strength, between two human social atoms is directly related to the degree of attraction between two individuals and inversely related to their repulsion and the physical distance between them.[4]

In terms of movements of others in one's social hierarchies, according to Remer, Moreno's model helps in our understanding of how bonds change with time and how and why relationships move from level to level. In particular, as Remer suggests, 'for changes in level, both literally and figuratively, a quantum leap is required, like the movement of electrons from ring to ring. The energy invested in a relationship builds through the quantity and diversity of interaction until suddenly and uncontrollably the level of the relationship shifts. Although the conditions for such an energy increase can be induced, e.g. one can bring people together in a group, thus helping them go from nothing to acquaintanceship and even to collective contact, the transitions occur somewhat unpredictably.' Remer states that, according to Moreno's social atom theory, 'the deeper the level, the more energy is needed' and that 'at that level, there is less room available for people who cannot invest that degree of energy, where time availability may be the most limiting factor.' He concludes 'to maintain relationships at deeper levels, mutual energy contribution is necessary.'[6]

In 1956, in a manner analogous to Moreno, German psychologist Eric Fromm, in his renowned book *The Art of Loving* positioned the concept of the 'human atom' and postulated that the 'desire for interpersonal fusion is the most powerful striving in man.' In particular, according to Fromm, 'the deepest need of man is the need to overcome his separateness, to leave the prison of his aloneness.' Moreover, 'the absolute failure to achieve this aim means insanity.' Subsequently, bonding is a

great human need. He reasons, however, that not all fusions are adequate. In particular, 'herd conformity' is a type of weak union that is calm, dictated by routine, and for this very reason often insufficient to pacify the anxiety of separateness. He states:

> "Contemporary society preaches this ideal of unindividualized equality because it needs *human atoms*, each one the same, to make them function in a mass aggregation, smoothly, without friction; all obeying the same commands, yet everybody being convinced that he is following his own desires."
>
> — Erich Fromm, *German-American psychologist* [1956]

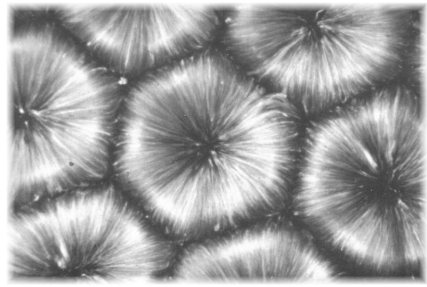
In building insight into the nature of the human chemical bond, with its exchange force composition, Fromm reasons that our whole culture is based on the appetite for buying; an interaction situated on the ideal of the mutually favorable exchange. The strongest appetite is for those products found in the mating market, such that 'falling in love develops with regard to such commodities as are within reach of one's own possibilities for exchange'.

On this premise, Fromm states that the thrill of life arises when window-shopping in the mating market with instinctual desires to find the newest, shiniest, fashionable, and most attractive mate product available. Furthermore, attractiveness, according to Fromm, embodies those attributes, such as physical appearance, personality, social values, and intellect, etc., that make for a nice package of qualities. Thus, Fromm reasons that what makes a person attractive, physically as well as mentally, depends on the fashion of the time. To summarize Fromm's views, two people (atoms) will fall in love when they both come to intuit that they have found the best object available on the market, considering the limitations of their own *exchange value*.

In the 1970s, Belgian chemical physicist and Nobelist Ilya Prigogine defined the human organism as a 'dissipative structure' based on observation that eddies or vortex-like structures, such as Bénard cells and Tornados, can be made to form spontaneously in fluid systems when subjected to gradients such as heat or pressure. Physical or chemical structures, according to Prigogine, are termed *dissipative* to 'emphasize the constructive role of dissipative processes in their formation' and as compared with the simpler structures they replace, they require more energy to sustain them.[7]

This view of human life in which humans are dissipative structures, however, is not perfectly correct. Prigogine based his notion of dissipation primarily on the heat dynamics of what is called Bénard cell formation. Bénard cells, as shown below, are

hexagonal structures that form whenever a dish of oil, such as silicon oil or sperm whale oil, is placed over a hot plate:



Bénard cells

The hexagonal structures will assemble into existence when the heat is turned up past the laminar flow régime, beyond a critical threshold value, and into the turbulent régime. In the formation of these hexagonal dissipative structures, Prigogine states that 'a new type of order has appeared', in which convection corresponds to the 'coherent motion' of ensembles of molecules, a motion that increases the rate of heat transfer, and moreover that 'we can speak of new coherence, of a mechanism of *communication* among molecules'.[7]

In short, Prigogine theorized that these little hexagonal structures, formed owing to an external heat gradient, a state of heat flow that he cumbersomely labels as *far-from-equilibrium*, are similar to the basic model for the thermodynamics involved in the formation of life. Specifically, 'this type of communication can only arise in far-from-equilibrium conditions' and 'it is quite interesting that such communication seems to be the rule in the world of biology.' He concludes 'it may in fact be taken as the very basis of the definition of a biological system.'

In reference to sociology, Prigogine, states that dissipative structures exist in nature, he refers to humans as 'macroscopic beings in a world far from equilibrium', and concludes that 'societies are immensely complex systems (highly sensitive to fluctuations) involving a potentially enormous numbers of bifurcations exemplified by the variety of cultures that have evolved in the relatively short span of human history.'

To clarify, however, although this is an interesting evolution model, with his anthropomorphic talk of 'communication between molecules' and mentality-like 'coherent structures', we know that in contrast to high-flow heat régime Bénard cells, evolving living biological systems actually require *less* energy to sustain them than as compared to their predecessors. Deciduous trees, for example, are more energy efficient than as compared to shrubbery, their evolutionary predicessors.[8] Nevertheless, by attaching the term 'dissipation' to word 'structure', Prigogine made a significant connection to the second law of thermodynamics, which is the law quantifies dissipation in terms of entropy changes in systems. In the history of

thermodynamics, the observation that moving, work producing, systems dissipate energy irreversibly has had great historical precedence. The proposal that there exists an irreversible dissipation of mechanical energy in nature traces it origins to the 1803 publication of *Fundamental Principles of Equilibrium and Movement* by the French mathematician and physicist Lazare Carnot, the father of French physicist Sadi Carnot the revolutionary founder of thermodynamics and the first to state the second law of thermodynamics.[9]

Lazare Carnot's paper included a discussion on the operation and efficiency of fundamental machines, e.g. those such as pulleys and inclined planes. Carnot saw through all the details of the mechanisms to develop a general discussion on the conservation of mechanical energy. Over the next three decades, Lazare Carnot's theorem was taken as a statement that in any machine the accelerations and shocks of the moving parts all represent losses of *moment of activity*, i.e., of the useful work done.[10] From this Lazare drew the inference that perpetual motion was impossible. This loss of moment of activity, or what would soon be called 'dissipation', was a precursory model for German physicist Rudolf Clausius' 1854 conception of entropy or transformation-energy, i.e. internal energy lost to irreversible internal molecular changes such as dissipation, friction, collisions, non-reversible interactions, and tensions, etc.

The first predominant paper to be written on the phenomenon of dissipation was the 1852 article entitled 'On a Universal Tendency in Nature to the Dissipation of Mechanical Energy' written by British physicist William Thomson (Lord Kelvin).[11] From the introduction to this paper, Thomson states 'the object of the present communication is to call attention to the remarkable consequences which follow from Sadi Carnot's proposition, that there is an absolute waste of mechanical energy available to man when heat is allowed to pass from one body to another at a lower temperature, by any means not fulfilling his criterion of a *perfect thermo-dynamic engine*, established, on a new foundation, in the dynamical theory of heat.' Thomson then argues, as it is inconceivable to think that mechanical energy can either be called into existence or annihilated, that we must reason that this *waste* referred to cannot be annihilation, but rather be a 'transformation of energy'. Clausius, to note, would later revolutionize science by utilizing Thomson's dissipation terminology in the concept of entropy in his *transformation-energy* formulation of the second law of thermodynamics.

Thus, Prigogine, in a way, was building on history. His conception of humans as 'dissipative structures' was an historical step. To clarify, however, we state absolutely that humans are 'molecular structures'. Correctly, two or more human molecules interacting in the form of a working system can be categorized, from one perspective, as a *dissipative system*, which can be defined as a system that involves irreversible processes, where energy available for work becomes degraded into less available forms by frictional agencies.[12]

All real processes are dissipative. In a dissipative system, the system is moving towards a state of equilibrium, which can be regarded as a point attractor in phase space; this is equivalent to moving towards a minimum of free energy.[13] Free energy, is the measure of the ability of a system to produce useful work. Hence, in nature, according to the laws of thermodynamics, there is an absolute tendency to the dissipation of energy whenever either heat produces work or when work produces heat. It is, however, rather incorrect to state that the human body itself is a dissipative structure, because only part of the total energy of human life, i.e. that portion associated with entropy, goes to dissipation. Humans, i.e. human molecules, can only be dissipative, for the most part, when acting on each other. This was how Clausius defined the concept of entropy, a kindred term to energy.

To summarize, humans, according to current views, are twenty-six-element biomolecular structures, which produce work through the process of evolution. This evolution process is situated on coupled or linked sets of human chemical reactions confined to solar thermodynamic cycles. Moreover, all natural systems dissipate energy, by virtue of the inevitable existence of heat-generated friction. This life friction is accounted for as transformation-energy and quantified by an expression called entropy, defined by Clausius.

In the 1978 article 'On the Thermodynamics of Biological Evolution', Russian physical chemist Georgi Gladyshev showed that people, as well as genera, families, associations, populations, etc., are each, when delineated by their own subsystem, molecular-structured organisms involved in a time-defined, hierarchical variation of supermolecular evolution.[14] He postulated that each subsystem, e.g. a group within a population, has distinct isothermal-isobaric potentials, such that the summation of all potentials for a subsystem yields a value for the total Gibbs free energy change, or evolution potential, of that subsystem. In other words, according to Gladyshev, the summation of subsystem potentials yields a value as to how far a particular biological system is from climax ecosystem level or end-cycle equilibrium.[15]

In recent years, many have comfortably arrived at the conclusion that the human organism is, by definition, a large biomolecular structure. In 1995, for instance, in the *British Homeopathic Journal* article 'Mechanism of Action of Homeopathic Medicines', physician B. Poitevin investigates and models the human organism as a molecule. He believes that there are no inherent differences between the mind and the body, and that they are essentially one and the same, a large differentiated structural molecule.[16]

In the 1999 book *Peopleware,* American software consultants Tom DeMarco and Timothy Lister likened occupational human workers with flexible and self-regulated working environments to 'free electrons' based on the observation that such loosely-bound employees have a strong role in choosing their own orbits or *work orbitals*. Interestingly, although humans are not free electrons, from the human molecule perspective one can construct human molecular orbitals.[17] In chemistry,

spatial shapes of molecules are determined according to molecular orbital theory, in which probability is used to define the movement patterns and shape of the components of a molecule. These same principles apply in human life.

Moving into the new millennium, there has been a growing plethora of the use of the ideal gas model for human behavior, particularly in economics, in which each 'agent' (human particle) is identified with a gas particle. Papers such as the 'Statistical Mechanics of Money' (2000), 'Money in Gas-like Markets: Gibbs and Pareto Laws' (2003), or 'Pareto and Boltzmann-Gibbs Behavior in a Deterministic Multi-agent System' (2008), model economies on the statistical behavior of large number of gas molecules.[18] The obvious flaw in this logic is that human molecules do not exist in the gas phase, they are molecules attached to a surface. Subsequently, rather than culling formulas from statistical mechanics of gas systems, it would be better to model human behavior on models from sciences such as *surface chemistry*, the study of how atoms and molecule interact with a surface, *drug-receptor thermodynamics*, the energetics of molecular movements in a fluid medium, or *supramolecular chemistry*, the study of reactions between supermolecules.[19]

Another recent off-target model used to describe human behavior is that of atom spin-alignment in ferromagnetic materials, used by English physicist Mark Buchanan in his 2007 book *The Social Atom* to describe 'tipping points' in human society. Tipping points, according to Malcolm Gladwell's 2000 book *The Tipping Point*, are points in time in which small-scale fads, trends, rumors, fashion sense, waves of crime, and other influences, 'tip' past a threshold and quickly spread through a society. The prime example being when, in 1995, the brushed-suede American shoes Hush Puppies suddenly became a national phenomenon, even though they had been around since 1958. In this mode of logic, Buchanan states that 'we should think of people as if they were atoms or molecules' and that modern physics should be able to outline 'how social atoms fit together'. He then argues that the tipping points involved in the 'physics of opinion' are explained as a phase change, similar to ice melting to water or to the loss of magnetization in ferromagnetic materials, which is due to the loss of ordering of the atom's spins when heated past a temperature called the *Curie point*. In the correct sense, human tipping points, in behavioral trends, are peaks of activation energy barriers in human molecular reaction transistion states.[20]

In sum, like other human particle theories, Buchanan only tip-toes around the idea superficially, and makes illogical statements, for instance, that with unique human atoms, being somehow different than other atoms (lacking free will), 'atomic-level chaos' that 'gives rise to the clockwork precision of thermodynamics' allows for individuals with free-will to come together into predictable patterns.

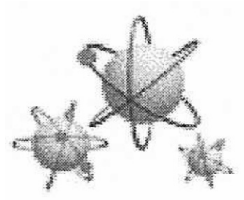
To recap on these various intermediate views, each model, namely human or social atoms, dissipative structures, and supramolecular structures, human electrons, etc., has grains of truth; technically, however, a human is a molecule, plain and simple, i.e. a structure composed of two or more atoms.

7 – Advanced Intelligence Perspective:

"Formerly in trying to comprehend a complex system, we sought the simplest units that explained matter and life: the molecule, the atom, elementary particles ... today, in relation to society, we are the particles."

Joel de Rosnay, *French biochemist* - 1975

In biology, the human organism is defined as a bipedal primate mammal.[1] In statistical physics, humans are studied en masse and envisaged as insensate particles of matter.[2] In the abstract field of complexity theory, humans are recursively defined as complex systems.[3] In chemistry, humans are a set of chemical species that share a mate recognition system.[4] Chemical species, in finer detail, as we know, are built from exacting selections of atoms:



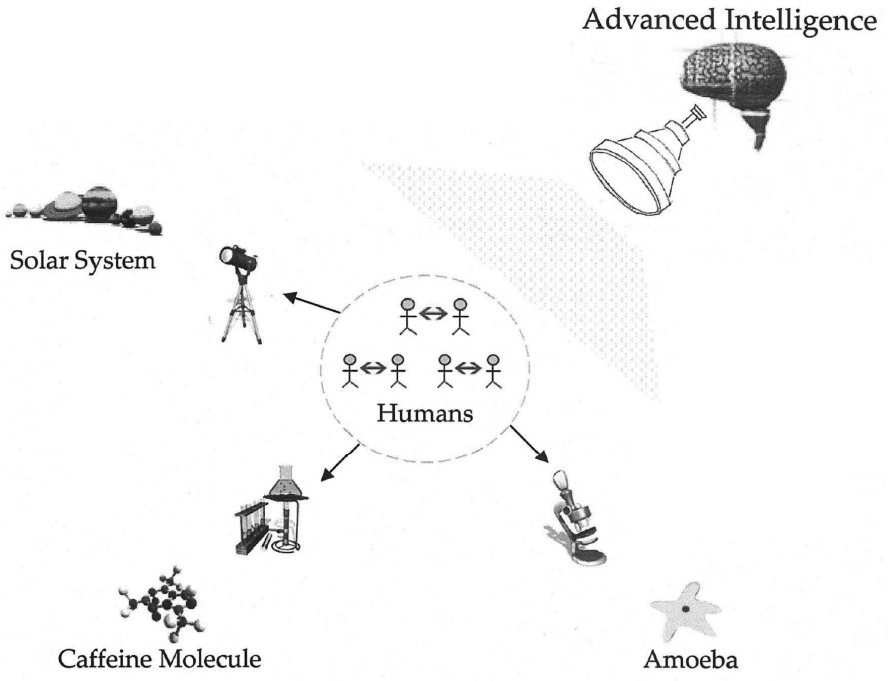
Atoms

In modern terms, to facilitate our chemical analysis of the human life process we will move away from an anthropocentric or human-centered view of the universe to that of a *moleculacentric* view of the universe. This viewpoint shift is justified by virtue of the absolute fact that all motile structures on the surface of the earth are molecular structures and in the individual case are defined as unique molecules, i.e. structures comprised of two or more atoms. This viewpoint, to clarify, is an extremely new and revolutionary perspective in the history of human thought.

Molecule – an aggregate of at least two atoms in a definite arrangement held by special forces.[5]

To elaborate on this, the *advanced-intelligence perspective* will be used. That is, to help visualize the concept of human chemistry, imagine that you were a grandiose form of advanced intelligence, of immense size, and you examined under your advanced high-powered microscope a vast collection of strange particles called 'humans'. Curious to explore the intricacies of their operation, you observe, over

time, how these particles *interact* with one another, as they zip about over a surface, to yield or reproduce new particles of like, but slightly evolved composition. In other words, we will study ourselves in the same manner as we currently study other systems, such as the solar system, small chemical systems, or microbial systems, etc. Thus, henceforth, we will utilize the advanced intelligence perspective to visualize humans as small systems of reactive molecules:



In addition, to elaborate further on the concept of 'interactions', whether human or otherwise, we set the following definition:

Interaction – the force exerted by one physical object upon another.[6]

Interactions, in general, can be defined as an effect involving a number of bodies, particles, or systems as a result of which some physical or chemical change takes place. In physics, *fundamental interactions* are four types of essential interactions, i.e. strong nuclear, weak nuclear, electromagnetic, and gravitational that occur between bodies, which together function to account for all observed forces in the universe.[7] Fundamental interactions are mechanisms in which particles interact with each other in ways that cannot be explained by another more basic interaction. Every observed physical phenomenon, human life included, from galaxies colliding with each other to quarks jiggling around inside a proton, can thus be explained by

interactions.[8] Electromagnetic interactions are responsible for the forces that control human life and in particular chemical reactions.[7]

From the advanced-intelligence perspective, due to relativistic speed effects, one minute of our advanced intelligence time equates to about ten years of human-time. Subsequently, by peering through our advanced microscope for several minutes we would be able to observe, catalog, analyze, and spatially quantify several decades of human evolutionary dynamics.[9] Through this advanced relativistic mode of analysis, we will study and analyze step-by-step human interactions from a time-accelerated, observational, distant scientific point of view.

One of the first to outline the need for this perspective was American author Oliver Reiser who, in 1935, as discussed, in commentary on Pareto's conception of human society as a system of molecules undergoing various combinations in space and time, stated that 'some critics might like to raise the question of how it is that if we, as individuals, corresponding to the molecules of a gas we can know anything of the total state'. He argues that, 'as constituents of a statistical ensemble we see what happens within the system, but only a *super-observer* could note from without those changing combinations which constitute the cultural patterns'. He concludes, 'the impossibility of such a human super-observer would seem to place a limitation upon the possibility of a science based on such assumption.'[10]

Similarly, in his 1951 essay 'The Mechanism of Evolution', Teilhard stated in relation to the process of evolution, that 'to an *observer at a sufficient height* to have a commanding view, it is to this process that is reduced, and in that process is harmonized, the combined play of all human activities, reacting on one another for nearly a million years'.

In the 1975 book *the Macroscope: a New Scientific System*, biochemist Joel de Rosnay likewise presents a perspective in which by looking through what he calls the 'macroscope', which observes the complexity of life from a distance, we might better understand human interactions. Just as the microscope studies the infinitely small, and the telescope studies the infinitely large, the *macroscope* studies the infinitely complex, i.e. society and nature. In its field of vision, according to Rosnay, elements, interactions, organizations, events, and evolutions are illuminated in a very different light. The macroscope filters details and amplifies that which links things together. It is not used to make things larger or smaller but to observe what is at once too great, to slow, and too complex for our eyes. Through the macroscope, human society is a gigantic organism that is normally totally invisible.[11] This point of view, essentially, is the advanced intelligence perspective. Formerly, in trying to comprehend a complex system, we sought the simplest units that explained matter and life: elementary particles, atoms, small molecules, etc. Today, as Rosnay states: 'in relation to society: *we are the particles* … our glance must be directed toward the systems which surround the particles in order to better understand their interactive and evolutionary dynamics.'

Another take on the need for an advanced intelligence perspective is found in the interesting 2001 paper 'Social Entropy', by Peruvian engineer Alfredo Infante, who argues for a thermodynamic or work-energy view of social behavior, we find the advanced intelligence mode of analysis being utilized, which Infante defines as the 'unsuspected visitor perspective'.[12] Infante postulates a keen hypothetical extraterrestrial observer, outside of our atmosphere, who is never visible to us, but is able to distinguish the movement of individual human beings. He surmises that the observer would watch as humans follow the second law of thermodynamics, i.e. the law that coordinates the direction of time, just as we watch how small molecules operate in accordance with the second law of thermodynamics.

Likewise, in 2003 book *The Human Web*, in which historians William McNeill and J. R. McNeill argue for a 'bird's-eye view' of world history. Human life and history, according to these historians, are best studied by focusing on webs of interactions. A human web, according to the McNeills, is 'a set of connections that link people to one another.' Furthermore, these connections, by definition, take the form of chance encounters, kinship, friendship, rivalry, enmity, economic exchange, belief systems, ecological exchange, political cooperation, and military interactions, among others. In relationship webs, people communicate information and use this information to guide future behavior.[13]

Human connections, from a bird's-eye view, are built from sensory interactions as well as material and emotional exchanges. This, however, does not elaborate on the actual chemical composition of the nodal entities in the web. In other words, if we were studying earth-bound interactions, with a large microscope, what sort of chemical terminology would we use to define the human particle (person)?

The answer is that, from the advanced analysis perspective, the astute person would label these puzzling and curious human particles as a 'type' of *molecule* just as we would any other collective mobile unit of matter in the universe; i.e. by the type, number, and arrangement of atoms composing its structure. In a modern sense, then we will investigate the sum human population, comprising over six billion reactive entities, and their relative interactions, exchanges, and resultant diurnal movement patterns through a distant observational perspective. That is, as a basis if we study and define each individual person as one large unique molecule in the same way we presently study macromolecules, such as DNA, or smaller molecules, such as H_2O, then each person would be defined as a human molecule. This will be the point of view followed in the remaining chapters and is considered the modern view.

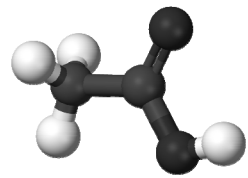
8 – Modern Views:

"Different molecules or humans behave differently, having different reactions or behaviors to changing chemicals or situations."

John Hodgson, *Fun Little Book of Molecules/Humans* - 2002

In the last decade or two, the view has emerged that the human being is technically a molecule and that the sciences of chemistry, thermodynamics, and physics govern their operations and interactions, in the same manner as is the case with small atoms and molecules.[1] Part of this has to do with recent construction and publication of various human body elemental mass composition tables. These include mass percent data sets as found in the 1991 article 'Chemical and Elemental Analysis of Humans *in vivo* using Improved Body Composition Models', the 1996 book *The Natural Selection of the Chemical Elements*, and the 2001 book *Nature's Building Blocks: an A-Z Guide to the Elements*.[2] Once a mass composition data table is available for any giving animate structure, listing elements by percent mass, it is a simple spread sheet calculation away to derive the molecular formula for the entity.

A formula is a way of representing a molecule, compound, or chemical species using symbols for the atoms present, where subscripts are used for the number of atoms.[3] The *molecular formula* simply gives the type and number of atoms present. The *empirical formula* gives the atoms in their simplest ratio. A *structural formula* gives an indication of the way in which the atoms are three-dimensionally bonded or arranged. The molecular formula of acetic acid, a 3-element organic molecule best recognized for giving vinegar its sour taste and pungent smell, for example, is $C_2H_4O_2$, whereas its empirical formula is CH_2O, and its structural formula is CH_3COOH, as is depicted visually in the following space-filling diagram:



Acetic acid (CH_3COOH)

Molecular formulas for larger life-like animated structures, such as bacteria, aquatic worms, fish, reptiles, shrews, lemurs, chimpanzees, humans, etc., generally being characterized by ten or more element molecular formulas (*xy*-element molecules), follow the same logic, with the exception that there is a fluxing dynamic turnover

rate of atoms (about 98% per year) in the structure of each dynamic molecule as the organism incorporates various elements from their surroundings, via ingestion, assimilation, or breathing, etc., and expel elements back into their surroundings, when they egest, defecate, excrete, lactate, or exhale, etc.[4] These are complicating factors that can be factored out per area of study, e.g. substrate interactions, intermolecular reactions, coupling energetics, etc.[5]

A second reason that, in recent decades, humans have come to be defined as molecules is the growing use of thermodynamics to explicate human economic or social life. In the 2006 book *The Origin of Wealth – Evolution, Complexity, and the Radical Remaking of Economics*, for instance, author Eric Beinhocker explicitly states that 'from a thermodynamic perspective, an organism is a collection of highly ordered molecules.' This mode of logic is a common one.

In general, to build a rigorous theory of social or economic thermodynamics to explain human life, one must ask: (1) what forces act on a single human molecule; (2) how do these forces assimilate to mediate the bulk behaviors of collectives of human molecules; (3) how are these forces and social behaviors mapped, equation-wise, into measurable social gauges and thermodynamic potentials. The first to apply this type of logic was Venezuelan chemical engineer Erich Müller.

Müller's human molecules

In the early 1990s, to help explain concepts more clearly in his thermodynamics lectures, Venezuelan chemical engineer Erich Müller began to conceive of people as molecules, such as to explain, for instance, how phase separations in fluid systems are similar to natural social segregations. Building on these early analogies, in his interesting 1998 *Journal of Chemical Education* article 'Human Societies: a Curious Application of Thermodynamics', Müller not only compared humans to molecules, but also correctly outlined a basic thermodynamic theory of human interactions.[6] In this article, he first defined humans to be analogous to molecules, then quantified inter human molecular love and hate in terms of basic thermodynamic pair bonds, and lastly quantified social forces as a type of van der Waals dispersion force.[7]

Müller reasoned that just as basic *statistical thermodynamics*, which is the study of the microscopic behaviors of thermodynamic systems using probability theory, predicts macroscopic behaviors of systems through knowledge of intermolecular interactions and appropriate averaging among the large number of molecules that constitute a system, that, in human social terms, if we can come to understand the collective behavior of the system we then comprehend the interactions on an individual basis.[8] Using this logic, together with the concept of 'potentials' from classical thermodynamics, he explains correctly how social interactions are functions of quantum electrostatics and thermodynamics.

Müller, who is currently is a reader (professor) in thermodynamics at the Imperial College London, is well versed in thermodynamics, particularly on the subject of molecular dynamics in fluid systems.[9] Between 1988 and 2006 he published over 43 articles in this field, from a 'Theory of Simulation of Associating Fluids' (1994) to 'Mesoscopic Simulation of Aggregation of Asphaltene and Resin Molecules in Crude Oils' (2006).[10] In 2002, he published *Basic Thermodynamics*, an introductory textbook.[11]

Beginning in 1990s, to enlighten his lectures and to get his students interested, Müller began to compare people to molecules. This later resulted in his 1998 article 'Human Societies: a Curious Application of Thermodynamics', where he compared human bonds to hydrogen bonds and social and political bonds to van der Waals dispersion forces.[12]

In his article, he begins his hypothesis that humans and molecules are the same and that social systems can be described by thermodynamics; the latter of which, he justifies by noting that the original founding fathers of thermodynamics, namely, 'Watt, Clausius, Carnot, Joule, and Gibbs' had no 'appreciable comprehension of the exact constitution of matter'. As such, the laws of classical thermodynamics are framed such that they can be applied to most systems. This happy occurrence, according to Müller, is the essential reason we can extrapolate the fundamental concepts of thermodynamics to other disciplines, such as geology, medicine, and sociology. In caution, however, Müller states that analogies must be made carefully and that, in reference to social forces, 'the fundamental electrostatics and quantum mechanics needed to fully explain the nature and form of intermolecular forces are beyond the scope of this discussion.' These 'beyond the scope' discussions, Müller is referring to here, are what constitute the sciences of human chemistry and human thermodynamics.

Nevertheless, he continues with excellent statements, such as 'the solidness of a society depends on the strength of the particular bonds among their members.' In addition, there is a 'loose analogy between the intermolecular forces that govern observable behavior in fluid systems and the social forces that drive human behavior.'[12] According to Müller, we understand pressure as a result of forces between molecules in a fluid; whereby, we can understand the collective behavior of the system if we can comprehend interactions on an individual level. In human molecular terms, these pressure correlations have been confirmed.[13]

Müller further elaborates on the fact that even the most insignificant molecule of the simplest compound interacts with its neighbors by means of specific forces. The underlying cause for the presence of these forces is the physical separation of positive and negative charges in the atom. He goes on to present the argument that both molecules and humans are governed by roughly similar electromagnetic potentials. Instead of speaking of forces, Müller states, 'thermodynamicists prefer to talk about potentials, whose variation with respect to distance represents the force;

potentials have the advantage of having units of energy, thus a discussion of some concepts is simplified.'

These potentials, Müller refers to are the enthalpic *H* and entropic *S* potentials, whose combined effects culminate in the measurement of the Gibbs free energy *G*, as defined in system energy evolution terms by the combined law of thermodynamics, previously known as the chemical force of *elective affinity*, defined originally in 1687 by Newton and used by Goethe in 1809 to describe human relationships.[14]

Hence, as Müller explains, close proximity between molecules results in a state of 'repulsion', intermediate proximity results in a state of 'attraction', and at large distances, both humans and molecules do not interact directly and the potential is effectively zero. In intimate relationship terms, we understand these balancings of attractions and repulsions in terms of *Gottman stability ratios*.[15] Here, by analogy, we should be able to understand stabilities of any social system in terms of *Müller stability ratios*.[15] This is an area in need of further researcher.

To give an example, Müller discusses the behavior of individuals at a party. As the guests enter the room, 'the first thing they do, after serving themselves a drink, is to mingle, wandering without direction.' Müller continues, 'they place themselves at judicious distances, not too close but not too far away, from others—a distance corresponding to the minimum of the *interhuman potential*. If we attempt to get too close to an individual, there will be an inherent repulsion.' To elaborate on this further, in his 1998 article, Müller draws a graph with 'force' as the vertical-axis, 'distance' between centers of mass on the horizontal-axis, and the potential interaction curve starting high in force at extreme close interactions, dipping to a minimum at intermediate distances, and petering out to a negligible value when interpersonal distances are great. Müller then states correctly that when the potential is negative, 'it represents a minimum corresponding to a distance at which the molecules find a balance between attractive and repulsive forces.' On his nice plot, we find a depiction of two people fighting at close range, a group of people watching a movie at intermediate range, and an isolated person reading a book on the beach at interpersonal distances involving no appreciable interaction.

According to this logic, as Müller states, 'both at a human and a molecular level, even when the individual interactions may be somehow different and the fluctuations around the mean significant, the ensemble will have seemingly homogeneous properties if the number of individuals studied is extremely large.' Thus, 'if we start from the premise that molecules and humans are governed by roughly similar electrostatic potentials, thermodynamics may well describe the latter.' Moreover, 'the thermodynamic laws applicable to fluids may possibly describe some aspects of human society.'

Overall, one of Müller's central human molecular theories is that dominant social aggregations, such races, social classes, ghettos, Marxist societies, etc., result due to an electromagnetic force similar to that of *van der Waals force*, also known as

the London dispersion force. Dispersion forces are those that are weak in comparison to those found in covalent bonds. In human molecular terms, dispersion forces are weaker social forces that function to organize society. These forces are significant, but are weaker forces as compared to those found in the dihumanide bond 'A≡B'.

Müller explains that in a multi-component fluid system, each molecule will have its own peculiar interaction. He states that even though the qualitative shape of each molecule of the same species will be similar, that there will always be subtle and varying differences among members. If, for example, according to Müller, 'there are two types of molecules, say type *A* and type *B*, the potential minimum might be deeper between self-self *A-A* and *B-B* interactions than with unlike *A-B* interactions.' Müller further states that in a complex fluid, analogous to a complex, but fluid, human society, there might be symbiotic relationships: 'two molecules may bond for mutual benefits, such as exemplified by electron-transfer bonds, or there may be a strong repulsion due to dissimilar cross-interaction forces.' Similarly, Müller continues, 'in human society, our own individuality will draw us to some people while we strongly dislike others.' This phenomenon was eluded to, but not discussed much, in the subtitle ('Why Your Neighbor Usually Looks Like You') of Buchanan's 2007 book *The Social Atom.* Müller, in contrast, defines segregation in systems of molecules as *intermolecular racism*. Systems of oil molecules when placed into a system of water molecules, being so different from their neighbors, will tend to 'migrate to a boarder, avoiding unfavorable interactions.' If other nearby oil molecules are present, according to Müller, 'they will attempt to aggregate in the form of a molecular ghetto, thus achieving a more stable system.'

Müller's also elaborates that in small heterogeneous molecular social systems, if minority molecules, having similar attraction preferences, are present in significant numbers, 'a phase separation will occur, creating a region where all interactions will be favorable' since all the members of the phase would be compatible in interaction behaviors. The border with the surrounding homogeneous phase, however, 'will not be free from high interfacial-tension.' The analogy with a homogeneous society, where small racial, cultural, and or religious groups appear, according to Müller, is obvious. Müller points out that world history is plagued with ample examples, such as the persecution of native inhabitants during the colonization of the Americas, the separation of Pakistan and India, the Arab-Israeli conflict, and the disintegration of the Balkan states.[12]

In sum, according to Müller, all human social behavior, including love and hate, is governed by an 'interhuman potential' similar to that of insignificant molecules. In addition, these interhuman potentials are electromagnetic potentials that can be quantified in thermodynamic terms. Said another way, on the surface of the earth, it's not gravitational potentials that direct human behavior, but the electromagnetic force, i.e. like people will naturally electromagnetate towards each other.

In 2006, Müller was interviewed by journalist Laura Gallagher, with *Reporter magazine,* about his popularity for his invigorating thermodynamic lectures in which he draws analogies between molecules and people. In the resulting article titled 'A Thermodynamic Personality', Müller states 'I make lectures a little more light-hearted to get everyone interested. Thermodynamics can be very close to everyday things but some of the textbooks can make it seem abstract. There is no need for it always to look that scary.' Likewise, according to Gallagher, Müller compares people with molecules to help his students understand interactions between molecules and visualize how they behave. 'Liquids come together because their molecules attract each other, just like human beings, who like to get close together at parties. However, molecules repel each other when they are too close in the same way that no one wants to be approached by a close-talker.'[16]

These individual characteristics account for molecules' collective behavior. A group of the same type of molecules will stick together, just as a group of people might 'oil and water don't mix because they have a very different interaction—they prefer to be amongst molecules similar to each other instead,' he said. 'This is like humans and ghettos—in Copenhagen, for example, they tried to integrate the immigrant population with the otherwise rather homogeneous population by placing people in different parts of the city, but the immigrants eventually moved together and formed a ghetto,' he explained.[16]

'However, in a mayonnaise, you can have oil and water mixed together in an apparent single phase provided you have a molecule called a *surfactant*, which is fancied by both and can bring them together. In a similar way, only by including people who can talk to conflicting sides can different groups mix,' he continued. In these bold statements, Müller is generations ahead of himself.

Beyond theoretical analogies, the first to actually go beyond metaphor and to put an actual formula to the atomic definition of a human being as a molecule were American limnologists Robert Sterner and James Elser.

Sterner and Elser's empirical human molecular formula

In April of 2000, American evolutionary limnologists Robert Sterner and James Elser made the first-ever calculation of the empirical molecular formula for a human being.[17] They published their results in the 2002 book *Ecological Stoichiometry: the Biology of Elements from Molecules to the Biosphere*. On page three, they state that 'from the information on the quantities of individual elements, we can calculate the stoichiometric formula for a living human being to be', taking cobalt (Co) as unity:[4]

$$H_{375,000,000}\ O_{132,000,000}\ C_{85,700,000}\ N_{6,430,000}\ Ca_{1,500,000}$$
$$P_{1,020,000}\ S_{206,000}\ Na_{183,000}\ K_{177,000}\ Cl_{127,000}\ Mg_{40,000}\ Si_{38,600}$$
$$Fe_{2,680}\ Zn_{2,110}\ Cu_{76}\ I_{14}\ Mn_{13}\ F_{13}\ Cr_{7}\ Se_{4}\ Mo_{3}\ Co_{1}$$

In technical terms, this amounts to a 22-element human empirical molecular formula. They conclude 'this formula combines all compounds in a human being into a single abstract *molecule*'. They continue, 'our main purpose in introducing this formula for the 'human molecule' is to stimulate you to begin to think about how every human being represents the coming together of atoms in proportions that are, if not constant, at least bounded and obeying some rules.'

What is interesting in this calculation is how they arrived at it. In particular, being limnologists, i.e. scientists who study bodies of freshwater, their home turf is freshwater *plankton ecology*, which is the study of systems of passively floating or weakly swimming usually minute animal and plant life in bodies of water. From this basis, one of the key observations that drew them into the study of *ecological stoichiometry*, or patterns of mass balance in chemical conversions of different types of matter, was the observation that even closely related animal species of similar size and built on common body architecture can differ in the content of major elements such as N and P.[18]

The lack of understanding of this puzzle, they argue, is due the limited and diffuse data on elemental composition in different species. The goal of their book, as they state, is to emphasize the 'importance of basic data on elemental composition of different living species'. Moreover, they declare that ecological stoichiometry is about 'how chemical elements come together to form evolved, living species in ecosystems.' The abstraction followed in this new science, according to Sterner and Elser, is that:

> Organisms can be thought of as complex evolved *chemical substances* that interact with each other and the abiotic world in a way that resembles a complex, composite, chemical reaction.
>
> — Sterner and Elser, *American limnologists* [2002]

In more detail, as they state, 'the stoichiometric approach considers whole organisms as if they were single abstract molecules'. In addition, 'ecological interactions invariably involve chemical rearrangements'.

In discussion on this reductionist approach, they note that 'we sometimes hear the criticism that we wish to treat organisms as if they were *just* chemical reactions.' To this, their response is 'what do you mean by 'just'?' They clarify, in excellent character, 'organisms *are* chemical entities and are produced, maintained, and propagated by chemical reactions, albeit in the form of highly complex coupled networks, which are the product of evolution.'[19]

In summary, they state that 'like any other normal chemical rearrangement at the surface of the Earth, when organisms interact, mass must be conserved and elements

are neither created nor destroyed.' Moreover, 'there is stoichiometry in ecology, just as there is in organic synthesis in a test tube'.

In September of 2002, being unaware of the work of Sterner and Elser, the second person to calculate the molecular formula for a human being was American chemical engineer Libb Thims, who since 1995 has been trying to understand how the sciences of chemical reactions and chemical thermodynamics applied to the prediction and regulation of intimate human relationships.[17]

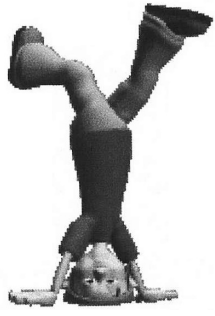
Thims' human molecules

In 1995, American Libb Thims, a chemical engineering student at the University of Michigan, began to wonder how basic human reactions could be pre-calculated to determine reaction feasibility using Gibbs free energy reaction algebra, similar to that used with small chemical reactions.[20] The basic reaction Thims had in mind was the ubiquitous reproduction reaction, through which 85% of people go through, in which a man *A* meets, reacts, and begins to bond with a woman *B* and in which over the course of the next fifteen years or so produce the product *C*, an offspring:

$$A + B \rightarrow C$$

This reaction is the focal point of life. In this direction, over the next dozen years, Thims began researching on and searching for, as a sort of hobby, answers on how chemical thermodynamics could be used to understand the intricacies of human romantic reactions, similar to how Johann von Goethe used the theory of elective affinities in 1809 to understand the vicissitudes of romantic life.

This effort resulted in the writing of four manuscripts, between 2002 and 2005, a three-volume *Human Thermodynamics*, a 100-page *Cessation Thermodynamics*, and the publication of the 2007 textbook *Human Chemistry*.[21] During this time, the calculation of the molecular formula for the human molecule was made.[22] The result of that calculation is shown below for a 70-kg (154 lb) person, which shows the human being to be a 26-element molecule:



Human Molecule

$$C_{E27}H_{E27}O_{E27}N_{E26}P_{E25}S_{E24}Ca_{E25}K_{E24}Cl_{E24}Na_{E24}Mg_{E24}Fe_{E23}F_{E23}$$
$$Zn_{E22}Si_{E22}Cu_{E21}B_{E21}I_{E20}Sn_{E20}Mn_{E20}Se_{E20}Cr_{E20}Ni_{E20}Mo_{E19}Co_{E19}V_{E18}$$

This chemical expression, according to the collection of various mass composition data tables used by Thims, particularly Emsley's 2001 *Nature's Building Blocks: an A-Z Guide to the Elements*, is the average molecular formula for one human organism.[23] In this formula, the symbol 'E' is shorthand notation for the power of ten. Hence, the term C_{E27}, for instance, signifies that there are 10^{27} carbon atoms in the molecular formula for an average person.

In comparing Thims' calculation to Sterner and Elser's calculation, one will notice a difference of four elements between the two formulas. This has to do with variations in references. Namely, some human composition data tables list as few as 10-elements and others list as many as 55-elements.[24] The key point to focus on in calculating molecular formulas for animate structures is the functional aspect of each element. If one accidentally swallows a gram of uranium, element 92, for instance, that does not mean that it becomes part of the functioning molecular formula. One has to first find significant biological function with an element before including it into an entity's molecular formula. The formula derived by Thims was done using a meta-analysis of 21 mass composition tables, 7 nutritional almanacs, 4 biochemistry texts, and several waste excrement data sets.[25]

The first to understand the logic of Thims' conception of the evolving human molecule and to begin to use it in theory, in 2005, was Russian physical chemist Georgi Gladyshev, author of the 1997 book *Thermodynamic Theory of the Evolution of Living Beings*.[26] In his 2006 *International Journal of Molecular Sciences* article 'The Principle of Substance Stability is Applicable to all Levels of Organization of Living Matter', Gladyshev outlines his theory of hierarchical thermodynamics, i.e. the application of Gibbsian thermodynamics to the study of system hierarchies in the biosphere, and concludes that:[27]

> "The conclusions of hierarchical thermodynamics correspond excellently to the conception of Libb Thims about the thermodynamics of *human molecules*."
>
> Georgi Gladyshev, *Russian physical chemist* [2006]

Moving forward, the following definition clarifies the term 'human molecule':

> **Human molecule** – the human chemical species defined as a twenty-six element biomolecule, capable of both isolated and associated existence, whose reactions, i.e. interactions, over substrate, are governed strictly via the combined principles and laws of chemistry.[28]

Thims was forced into the calculation of the human molecular formula, from the necessity in a chapter in the newly forming manuscript *Human Thermodynamics,* titled 'What Happens to a Person When They Die', to define exactly, from a fundamental particle point of view, what constitutes the totality of a 'human being' at

the moment of death (cessation).[29] Subsequently, from a chemical, particle physics, or conservation of matter-energy (first law of thermodynamics) point-of-view, the composition of a person, at the instantaneous moment of death, is defined as a 26-element molecule combined with its substrate materials (personal wealth), and photon-based energy consortium of interpersonal human chemical bonds.

The laws that govern the behavior of these human molecules are the laws of science; which derive predominately from sciences of chemical thermodynamics, quantum electrodynamics, particle physics, and supramolecular chemistry, respectively. The prefix '*bio*-' is used to signify that human molecules are of the biological classification, a distinct subgroup of all molecular structures. Hence, in the science of human chemistry, by definition the *human molecule* is the smallest component of the social collective that can take part in a *human chemical reaction*.[28]

In general, in the human molecule, each element has a generalized function, as shown in the following table:

#	Name	Symbol	% By Mass	Function in the Human Body
1	Oxygen	O	61	Roughly 60% of the body is H_2O, which is essential for almost all chemical reactions within the body.
2	Carbon	C	23	Is a major elemental component of carbohydrates and fats.
3	Hydrogen	H	10	Is a major elemental component of proteins, carbohydrates, and fats.
4	Nitrogen	N	2.6	Is a major elemental component of proteins.
5	Calcium	Ca	1.4	Used in the development and maintenance of bone structure and development. Functions in the clotting process, nerve transmission, muscle stimulation, parathyroid hormone function, and metabolism of vitamin D, etc.
6	Phosphorus	P	1.1	Plays a part in almost every chemical reaction within the body because it is present in every cell. Forms calcium phosphate with calcium in the bones and teeth in a 2-1 ratio. Is important in the utilization of carbohydrates, fats, and proteins for growth, maintenance, and repair, etc.
7	Potassium	K	0.3	Functions mainly in the intercellular fluid as the primary ion force. Potassium together with sodium helps regulate the water balance within the body. Potassium regulates the transfer of nutrients to the cell, transmits electrochemical impulses, and is necessary for normal growth enzymatic reactions, etc.
8	Sulfur	S	0.2	Keeps hair glossy and smooth and keeps the complexion clear and youthful. Sulfur is an

				important elemental constituent of thiamin, biotin, methionine, cystine, and cysteine. It disinfects the blood, resists bacteria, and stimulates bile production in the liver, etc.
9	Chlorine	Cl	0.18	Helps regulate acid alkali balance, stimulates production of hydrochloric acid, stimulates the liver to function as a filter for wastes, aids in keeping joints and tendons in youthful shape, and helps distribute hormones, etc.
10	Sodium	Na	0.17	Is found in every cell in the body. Sodium functions with potassium to equalize the acid-alkali factor in the blood. Along with potassium, it helps regulate water balance within the body. Sodium keeps blood minerals soluble, so they will not build up as deposits in the bloodstream, etc.
11	Magnesium	Mg	0.029	70% of the bodies magnesium supply is located in the bones together with calcium and phosphorus, while 30% is found in cellular fluids and some soft tissue. Is involved with energy production of glucose, protein and nucleic acid synthesis, the formation of urea, vascular tone, muscle impulse transmission, electrical stability of the cells, and neurotransmission, etc.
12	Iron	Fe	0.012	The major function of iron is to combine with protein and copper in making hemoglobin. Iron builds up the quality of the blood and increases resistance to stress, the immune system, energy production, growth in children, and resistance to disease.
13	Fluorine	F	0.004	Research indicates that fluorine increases the deposition of calcium, thereby strengthening the bones. Helps reduce the formation of acid in the mouth caused by carbohydrates, thereby reducing the likelihood of tooth decay.
14	Zinc	Zn	0.003	Helps fight disease, protect the immune system, involved in the Krebs cycle, has been found to increase the male sex drive, is a constituent of more that 2,000 enzymes involved in digestion and metabolism, etc.
15	Silicon	Si	0.001	Is needed for the connective tissues of the body such as the tendons, cartilage, blood vessels, nails, skin, and hair, and is essential for their integrity. Silicon works with calcium to make strong bones, proper levels are essential during growth periods, and it is helpful in the prevention of cardiovascular disease, etc.
16	Copper	Cu	0.0003	Involved in the synthesis of hemoglobin, collagen, and the neurotransmitter noradrenalin. Is an important blood antioxidant, prevents the rancidity of polyunsaturated fatty

				acids, and helps cell membranes remain healthy.
17	Iodine	I	0.00003	Aids in the development and functioning of the thyroid gland, and is an integral part of thyroxine. Iodine plays an important role in regulating cellular oxidation, promotes growth and development, and stimulates the basal metabolic rate—helping the body burn excess fat.
18	Tin	Sn	0.00003	Deficiency results in poor growth and diminished hemoglobin synthesis.
19	Boron	B	0.00003	A trace mineral essential for healthy bones.
20	Selenium	Se	0.00002	Is a natural antioxidant that protects against free radicals and appears to preserve elasticity of tissue that become less elastic with aging. Is necessary for the production of prostaglandins, and pancreatic function depends upon selenium, etc.
21	Chromium	Cr	0.00002	Stimulates the activity of enzymes involved in the metabolism of glucose for energy and the synthesis of fatty acids and cholesterol. It appears to increase the effectiveness of insulin and its ability to handle glucose, preventing hypoglycemia or diabetes. The mineral may also be involved in the synthesis of protein through its binding action with RNA molecules.
22	Manganese	Mn	0.00002	Functions as an important antioxidant in the prevention of toxic oxygen forms. It plays a role in activating numerous enzymes that are necessary for utilization of choline, biotin, thiamine, and ascorbic acid. Is a catalyst in the synthesis of fatty acids, cholesterol, and mucopolysaccharides, etc.
23	Nickel	Ni	0.00002	May be a factor in hormone, lipid, and membrane metabolism and cell integrity. Significant amounts are found in DNA and RNA. May be involved in glucose metabolism, etc.
24	Molybdenum	Mo	0.000007	Is an essential part of two enzymes: xanthine oxidase—which aids in the mobilization of iron from the liver reserves and helps change iron from ferrous to ferric, and aldehyde oxidase—which is necessary for the oxidation of fats. It is also a factor in copper metabolism, nitrogen metabolism, and the final stages of urine production, ect.
25	Cobalt	Co	0.000004	Necessary for the normal functioning and maintenance of red blood cells as well as all other body cells; and is a constituent of vitamin B12.
26	Vanadium	V	0.0000002	Has been shown to reverse diabetes. Inhibits

				cholesterol synthesis. Bones, cartilage, and teeth require it for proper development. It has been shown to have a function in cellular metabolism, iron metabolism, and red blood cell growth, etc.

Thims' interest in human molecular reaction theory derived from the core logic of chemical thermodynamics. The basic tool or function of chemical thermodynamics is reaction prediction. Namely, given a system of chemical species, by measuring certain parameters, such as the enthalpy and entropy of the molecules, one can predict the spontaneity of the potential reaction, i.e. whether it will go or not, for virtually all chemical reactions. The essence of these types of reaction calculations is embodied in standard thermodynamic tables, such as shown below for several common organic molecules:

Species	Formula	ΔH_f°(kJ/mol)	ΔG_f°(kJ/mol)	S°(J/K·mol)
Acetic acid(l)	CH_3COOH	-484.2	-389.45	159.83
Acetaldehyde(g)	CH_3CHO	-166.35	-139.08	264.2
Acetone(l)	CH_3COCH_3	-246.8	-153.55	198.74
Acetylene(g)	C_2H_2	226.6	209.2	200.8
Benzene(l)	C_6H_6	49.04	124.5	172.8
Carbon dioxide(g)	CO_2	-393.5	-394.4	213.6
Ethanol(l)	C_2H_5OH	-276.98	-174.18	161.04
Ethane(g)	C_2H_6	-84.7	-32.89	229.49
Ethylene(g)	C_2H_4	52.3	68.1	219.45
Formic acid(l)	$HCOOH$	-409.2	-346.0	128.95
Glucose(s)	$C_6H_{12}O_6$	-1274.5	-910.56	212.1
Methane(g)	CH_4	-74.85	-50.8	186.19
Methanol(l)	CH_3OH	-238.7	-166.3	126.78
Oxygen(g)	O_2	0	0	51.05
Sucrose(s)	$C_{12}H_{22}O_{11}$	-2221.7	-1544.3	360.24
Water(l)	H_2O	-285.8	-237.2	69.9

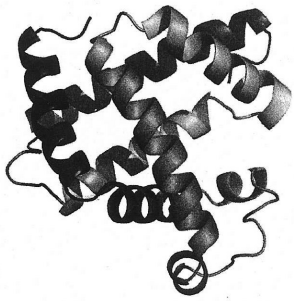
In short, for a reaction between chemical species (or molecule) *A* and species (or molecule) *B* to occur and yield the product *C*, such as shown below:

$$A + B \rightarrow C$$

there has to be a negative change in the Gibbs free energy of the reaction system. In simple terms, this means that due to system inherent atomic structure or bonding reconfigurations, a natural energy will be released and the chemical reaction will go spontaneously on its own.[30] These calculations are commonplace for small chemical species, such as those shown in the formula column of the table.

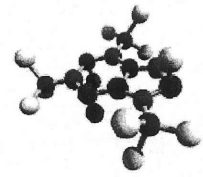
In 1882, to note, German physician and physicist Hermann von Helmholtz showed that the change in free energy ΔG is the measure of affinity (elective affinity) of a chemical reaction.[31] Hence, what Goethe was doing in 1809 with his theories of human 'elective affinities' is the same in modern terms as human molecular reaction 'free energies' between people.

In this mode of logic, then, from a chemical point of view, the human molecule is no different than any other dynamic molecule, be it a water molecule H_2O, a RNA molecule, or a supermolecule, etc.[32] Below, for comparison, are the dynamic entities of a protein molecule and a caffeine molecule.



Protein Molecule

$C_{400}H_{620}O_{120}N_{100}P_{30}S_{15}$



Caffeine Molecule

$C_8H_{10}N_4O_2$

The synthesis of larger molecules from smaller sub-components is called *molecular evolution*, a process that involves the interaction of photons (energy particles) with valence shell electrons found at the periphery orbitals of atoms and molecules. The source of the majority of energy photons that drive earth-bound molecular evolution stem from proton-proton chain reactions inside the sun. In a nutshell, with respect to human molecular evolution, at about 4.6 billion years ago, the earth assembled out of the accretion disc of atoms, dust, and matter, found in fast rotation about the newly ignited sun. To clarify, when the sun first *lit*, this meant that proton-proton chain reactions had started, and that energy began to be released from the core of the sun as a result. This energy then drove forward the formation of life on earth.

Proton-proton chain reactions

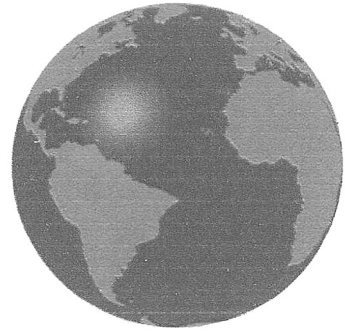
In simple terms, a *proton-proton chain reaction* is a process in which four hydrogen protons ^1H combine to form one helium nucleus ^4H, during the course of which a small amount of mass is converted into energy, in the form of, predominantly, gamma-ray photons γ. Eighty-five percent of the sun's total energy production or output derives from the following three-step proton-proton chain reaction, in which about 6 MeV of energy is released per reaction cycle:

Step	Reaction	Energy
1	$^{1}H + {}^{1}H \rightarrow {}^{2}H + e^{+} + \nu$	0.42 MeV
2	$^{1}H + {}^{2}H \rightarrow {}^{3}He + \gamma$	5.49 MeV
3	$^{3}He + {}^{3}He \rightarrow {}^{4}He + {}^{1}H + {}^{1}H$	

In these steps, ^{2}H is an isotope of hydrogen called *deuterium*, e^{+} is a *positron*, which is just like an ordinary electron except that it has a positive rather than a negative charge, ν is a *neutrino*, an uncharged elementary particle, and ^{3}H is a low-mass isotope of helium, whose nucleus contains two protons and one neutron. The portion of the energy released during this three-step reaction, in predominantly the form of gamma-ray photons γ, that impacts the globe of the earth (about 1,000 billion photons fall on a pinhead each second), over long periods of time, has powered the formation of larger and larger animated molecules culminating in the formation of human molecules.

Planetary-sized molecules

To situate the concept of the human molecule into a relative perspective, we also point out the interesting and inarguable fact that the earth itself is a large 92-element biogeochemical molecule:[33]



Earth Molecule

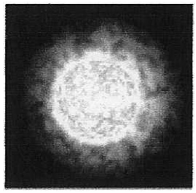
$O_{E50}Fe_{E49}Si_{E49}Mg_{E49}S_{E48}Al_{E48}Ni_{E48}Ca_{E48}Cr_{E47}Na_{E46}K_{E46}H_{E46}Ti_{E46}F_{E45}C_{E45}$
$P_{E45}Mn_{E44}Sr_{E44}Ba_{E44}Cl_{E44}V_{E44}Li_{E44}Zr_{E43}Rb_{E43}Zn_{E44}Cu_{E43}N_{E43}B_{E43}Ce_{E43}$
$Co_{E43}Sc_{E43}Nd_{E43}Ga_{E43}Be_{E43}La_{E42}Nb_{E42}Pb_{E42}Pr_{E42}Sm_{E42}Th_{E42}Gd_{E42}Dy_{E42}$
$Y_{E42}Ge_{E42}Ar_{E42}Er_{E41}Cs_{E41}Ur_{E41}Hf_{E41}Yb_{E41}Sn_{E41}Eu_{E41}Ta_{E41}As_{E41}Mo_{E41}$
$Ho_{E41}W_{E41}Tb_{E41}Br_{E41}Tl_{E40}Lu_{E40}Tm_{E40}He_{E40}Sb_{E40}I_{E40}Cd_{E40}In_{E40}Ag_{E40}Se_{E40}$
$Hg_{E39}Bi_{E39}Te_{E39}Ru_{E38}Pd_{E38}Au_{E38}Pt_{E38}Ne_{E38}Re_{E38}Rh_{E37}Os_{E37}Kr_{E36}Ir_{E35}$
$Xe_{E35}Ra_{E35}Pa_{E32}Ac_{E30}At_{E30}Po_{E30}Rn_{E28}Tc_{E23}Pm_{E23}Fr_{E23}$

In calculating the molecular formula for the earth, we note that elements with more than 92 protons in their nucleus do not occur naturally.[34] Subsequently, only

naturally occurring elements are included; i.e. man-made elements (93-118) are excluded from the above earth molecular formula as their quantities are negligible and extremely transient in structure.[35] Currently, for example, it takes researchers approximately eleven days of experimentation to make three atoms of element 118 (ununoctium), which decays less than a millisecond after creation.[36]

> “The earth is a self-organizing, self-regulating system maintained far from thermodynamic equilibrium under energy flow – in these respects, it is indeed like an organism.”
>
> – *Mae-Wan Ho*, thermodynamic research [1996]

Moreover, the sun itself, as another interesting molecular example, can likewise be defined as a large 10-element thermonuclear molecule:[37]

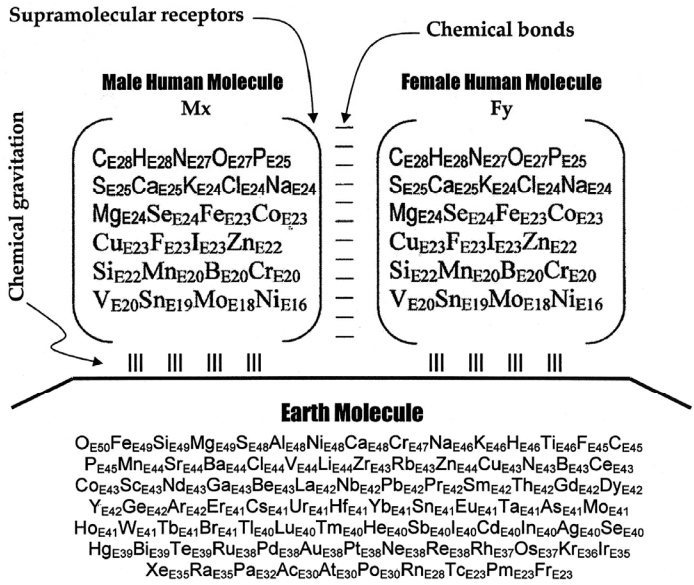


Sun Molecule

$H_{E57}He_{E56}O_{E54}C_{E53}Ne_{E53}N_{E53}Fe_{E52}Si_{E53}Mg_{E52}S_{E52}$

A point to note here is that the molecular formula for the sun is very approximate. Although the sun is predominately composed of three elements by percent mass, i.e. hydrogen (71.0%), helium (27.1%), and oxygen (0.97%), which would make the sun essentially a 3-element molecule, about 67 elements in total have been detected in solar spectrum.[38] Also, because thermonuclear reactions are continuously occurring within the sun, converting hydrogen into helium, which releases energy in the process, the traditional definition of a molecule, i.e. a structure comprised of two or more atoms, becomes subatomic and thus deviates a bit here.

Nevertheless, one salient point that mediates out of these definitions is that if relationship bonds between human molecules are enhanced or evolved types of chemical bonds, then so to is the bond that attaches each human molecule to the earth as well as the bond that attaches the earth to the sun. In other words, gravity or the force of gravitation, as it should be easily proved, is in actuality, an enhanced type of chemical gravitation, as shown below. This, however, is a subject of further inquiry.[39]



In sum, each of these dynamic molecules, i.e. the earth molecule, human molecules, protein molecules, caffeine molecules, etc., has a molecular life of its own; they seek out selective bonding sites, transform themselves as they interact with other molecules, evolve within each respective system, and are constrained and driven by the conditions of their environment, etc. Interpersonal human molecular life, of course, is the more fascinating topic; however, to better understand the process of human molecular life and its associative dynamics, we must first study preexisting molecular models, such as protein-protein molecular dynamics, drug-receptor molecular interactions, host-guest assembly molecular processes, etc. Associative dynamics, interactions, and bonding patterns found in these smaller molecular systems, may very well function as accurate models for human molecular life.

Free will

A significant point of conceptual difficulty that comes up as soon as one begins to adopt the human molecular perspective, as we have seen, is free will. In the history of human thought, *free will* is a conception that a person exercises control over the choices made in life. When one first begins to analyze the process of human life from either a chemical or thermodynamic point of view, such as Goethe did in 1809, as Adams did in 1910, or as C. G. Darwin did in 1952, this is one of the first major theoretical issues or topics of debate that arises.[40] In other words, from a chemical or thermodynamic point of view, a person is a molecule, i.e. a human molecule, no different than any other heat-driven animate molecule in the universe, and the actions or movements of molecules are determined Gauge boson exchange forces.[41]

The correct view, as Goethe discerned, is that a person does not have a free will, but only a 'perceptual free will'. In other words, the feeling that one is 'choosing their actions' is nothing more than a build up of electromagnetic potential, in the atomic neurological structure and photonic social bonding structure of the individual, that mediates the force of choice over other possible actions.[41]

The incorrect view that a person does have a free will implies that all molecules have a free will. This type of logic, being similar in concept to the various perpetual motion theories of history, however, leads to obvious theoretical absurdities. In 1956, for instance, Iranian engineer and human-thermodynamicist Mehdi Bazargan stated that: 'when dealing with human societies and humans with free will, thermodynamic law and formulae require a coefficient, which can be called a *balancing coefficient* and is less than 1 in unbalanced societies and more than 1 in societies governed by true religions and affections.'[42]

This type of flawed logic, wherein human beings are supposed to have special exceptions in the laws of science, is a common one. Darwin, as mentioned, reasoned that the 'unpredictability' of human molecules gives them a free will.

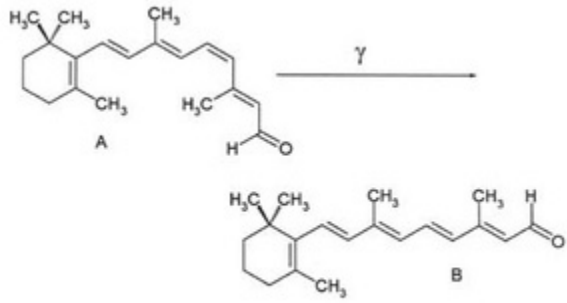
One of the first to state the correct view of free will, namely that from a molecular point of view, was Dutch philosopher Benedict de Spinoza, who in the 17th century stated that 'experience tells us clearly that men believe they are free simply because they are conscious of their actions and unconscious of the causes whereby these actions are determined; further, it is plain that the dictates of the mind are simply another name for the appetites that vary according to the varying state of the body.[43]

These varying electromagnetic states of the human molecular constitution, both mental and physical, from a human chemistry point of view, can be understood in an analogous fashion as being evolved forms of the 'octet rule', times 10^{27}, where atoms and molecules seek to satisfy their bonding orbital satieties; a motive driving process that actuates an energetic lowering or stability effect in the matrix of the system. In the words of Freud, the outline of this evolved effect can be summarized as follows:

> "By the pressure of an instinct, we understand its motor factor the amount of force or the measure of the demand for work which it represents. The aim of an instinct is in every instance satisfaction, which can only be obtained by removing the state of stimulation at the source of the instinct."
>
> – Sigmund Freud, *Instincts and Their Vicissitudes* (1915)

The resulting or mediating effect of the need or desire to satisfy the octet rule can be seen in the simple movement dynamics of the 3-element retinal molecule $C_{20}H_{28}O$, a light sensitive molecule found in the retina of the eye, which can be considered as the

basic reaction model for all animate molecular life. If the input energy contained in a single photon, when it strikes the molecule, is of the correct wavelength, between 400 and 700 nm, it will function, through the action of the movement of an electron upwards in an atomic orbital level, to break pi-bonds found between the eleventh and twelfth carbon atoms near the kink in the structure of the retinal molecule. When these pi-bonds break, this 'forces' the retinal molecule, due to octet rule stability constraints or necessity, to rearrange into a straightened configuration:



Retinal molecule $C_{20}H_{28}O$ photon-mediated conformational change

This model, in which an animated molecule is *forced* to react or move dynamically, to a photon or field particle stimulus, is the basic model (poster child) for human molecular life, i.e. for all human behavior. In other words, all molecular structures, from hydrogen to bacteria to treeshrew to human, are "forced" to evolve owing to sensory stimulus. More directly, as stated, at the age of 16, by Scottish physicist James Maxwell, the founder of electromagnetic theory:

"The only thing which can be directly perceived by the senses is Force."

The human molecule, a 26-element molecule (a more intelligent molecule), is no different, complexity aside, then the retinal molecule, a 3-element molecule (a less intelligent molecule). Human chemical reactions or human behavior will always be similar to the bending and straightening actions of the simple retinal molecule, in that field particle stimuli mediates reactionary behavior. Said another way, the central nervous system of the retinal molecule is no different than the central nervous system of the human molecule: each CNS is comprised, at its core, of valence shell electron-photon interactions.

This photon induced retinal-bending mechanism, to note, was discovered in 1958 by the American biochemist George Wald and his co-workers; work for which Wald won a share of the 1967 Nobel Prize in Physiology or Medicine with Haldan Keffer Hartline and Ragnar Granit.[44]

Related or cultural human molecular views

One of the earliest cultural references to the idea that a human is a molecule, in a way, was Marvel Comics 1963 fictional character *Molecule Man*, who first appeared in the Fantastic Four (#20) and later had his own comic series.[45] In the story, laboratory technician Owen Reece, while working at a nuclear plant owned by the Acme Atomics Corporation, one day, growing careless, accidentally activates an experimental particle generator, which bombards him with an unknown form of radiation. The radiation has a mutagenic effect on Reece, releasing his potential for psionic powers on a cosmic scale. Reece could now control all matter, even down to the molecular level, and all energy. He names himself the 'Molecule Man' after his power to control molecules.

In modern economics, one can find vestiges of the Walras-Pareto social theory of economic molecules. In the 1999 book *Natural Capital and Human Economic Survival*, for instance, we find neoclassical economics defined such that 'the welfare of human society is best served by the views of people as *human molecules* who, by pursuing their own interests through the market, inevitably promote the general good.'[46]

In the 2001 article 'The Thermodynamics of Love', American computational chemist David Hwang argues, similar to Thims, that chemical thermodynamic Gibbs free energy calculations determine the success of human romantic relationships.[47] He defines people as 'elements' and couples as 'compounds'. In particular, he states given 'a theoretical chemical reaction where two elements, male *M* and female *F*, combine to form a new compound called couple *M*-*F*:'

$$M + F \rightarrow M\text{-}F$$

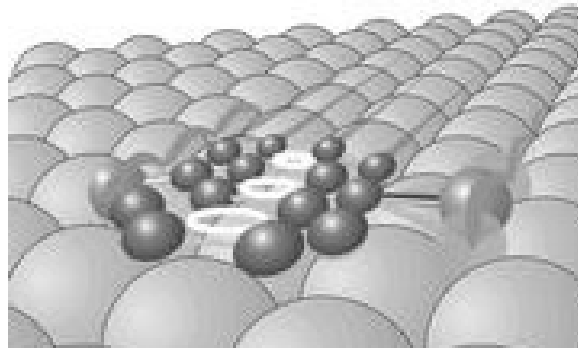
that to determine the likeliness that the given chemical reaction will proceed in the forward direction one needs to calculate the change in the Gibbs free energy ΔG as plotted out on a 'free energy' vs. 'extent of reaction' diagram.[48] To correct Hwang, *M* and *F* are not 'elements' but 'molecules', and *M*-*F* is not a 'compound' but a 'dihumanide molecule'.

In recent movies, similarly, some have begun to acknowledge that humans are molecules. In the 2001 comedy *Shallow Hal* starring Jack Black and Gwyneth Paltrow, for example, we find the following interesting statement, referring to the superficially physically attractive women in the movie:

> "They're just well formed molecules"
>
> – Movie: *Shallow Hal* [2001]

Likewise, in recent years, curiously, there has been a surge in publications as to whether or not the human is a molecule. In 2005, science writer Steve Fuller published the article 'I Am Not a Molecule' in the June issue of the *New Scientist* magazine. In this article, Fuller confronts Steven Pinker, author of *The Blank Slate*, Jared Diamond, author of *Collapse*, and Philip Ball, author of *Critical Mass*, for their supposition that human behavior can be understood when we cease to try to predict and analyze the behavior of individuals and instead look to the impact of hundreds, thousands or millions of individual human decisions, similar to how physicists study the bulk behavior of molecules in the gas phase.[49]

Similarly and somewhat remarkably, in September of 2005 a research team led German-born, American physical chemist Ludwig Bartels at the University of California Riverside designed a molecule that can walk in a straight line on a flat surface, like a little human being:



Walking Molecule

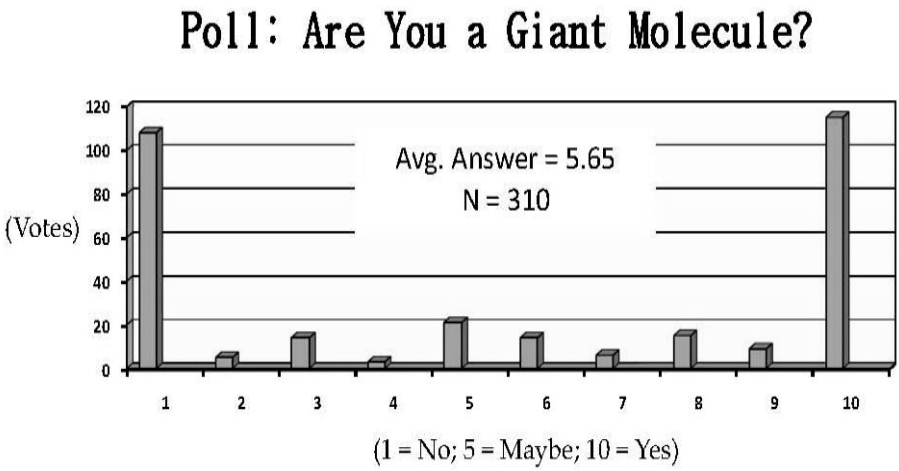
Interestingly, the news release for the results of this project, first published in the *Physics Review Letters*, was entitled 'Molecule Walks Like a Human.'[50] This tiny walking molecule, shown above, achieves this effect by mimicking the motor dynamics of a human walking.[51]

This tiny walking-molecule, called *9,10-dithioanthracene* or 'DTA', has two linkers that act like little mobile feet. Obtaining its energy by heat supplied to it (similar to human molecules), the molecule moves such that only one of the linkers is lifted from the surface; the remaining linker guides the motion of the molecule and keeps it on course. Without the assistance of non-rails or nano-groves for guidance, the little molecule is able to alternate the motion of its two 'feet' so to walk in a straight line. These published results generated a great deal of interest and made the American Institute of Physics 'Top 25 Physics Stories for 2005.'

In January of 2007, interestingly, Bartels' research team found a way to attach cargo: two CO_2 molecules (load), making the nano-walker a *molecule carrier* or worker. The new molecule carrier runs on a copper surface. It can pick up and release up to two carbon dioxide (CO_2) molecules and carry them along its straight

path. 'Carrying a load slows the molecule down' explained Bartels. 'Attachment of one CO_2 molecule makes the carrier need twice as much energy for a step, and a carrier with two CO_2s requires roughly three times the energy. This is not unlike a human being carrying heavy loads in one or both hands.'[52] He said his team will be pursuing the next step for this molecule carrier. 'Next, we would like to be able to make one go around corners, rotate its cargo or send out photons to tell us where it is.' This depiction, of human molecules looking at and studying simpler walking molecules, from a humorous perspective, might be analogous to how English naturalist Charles Darwin felt when, in 1838, he first looked at the great chimpanzees and realized they were related to us.

In a similar manner, from 2001 to the present, English physicist Jim Eadon has been running an excellent online poll to determine if people believe, in reality, that they are a giant molecule. As of February 2008, Eadon has polled over 310 people with the following query:[53]



The results of his study illustrate the fact that 57% of people agree that humans are giant molecules. From this data set, we see generally that people either strongly agree or strongly disagree with the proposition that humans are molecules; whereas, those who are ambivalent lean towards agree.

These 'ambivalent-leaning-towards-yes' results are to be expected, being that for one the science of *human chemistry*, the study of reactions between people, is a relatively new science, secondly that many articles and books are currently being published popularizing the 'human atom' metaphor, which is incorrect, and third that there are still many details about the human molecule that remain to be discovered. To further illustrate the obvious confusion that society has regarding what a human being technically is, the following incomplete list shows a rough outline of some of the various chemical-related terminologies used to define the human organism over the past 250-years:

#	Human Beings: historical terminologies	Author	Year
1	Complex Machines	*La Mettrie*	1748
2	Human Atoms	*Davy*	1813
3	Living Chiral Molecular Systems	*Pasteur*	1849
4	**Human Molecules**	*Taine*	1869
5	Heat Engines	*McCulloch*	1876
6	Animate Entropy Struggling Beings	*Boltzmann*	1886
7	A Kind of Molecule	*Pareto*	1896
8	**Human Molecules**	*Adams*	1910
9	Human Chemical Elements	*Fairburn*	1914
10	Energy Transformers	*Lotka*	1923
11	Automatons	*von Neumann*	1935
12	**Human Molecules**	*Teilhard*	1936
13	Negative Entropy Feeders	*Schrödinger*	1944
14	**Human Molecules**	*Darwin, C.G.*	1952
15	Open Thermodynamic Systems	*Denbigh*	1955
16	Entropy Reversal Systems	*Lovelock*	1964
17	Elementary Non-living Material Warps	*Blum*	1968
18	Dissipative Structures	*Prigogine*	1977
19	Self-Reproductive Macromolecular Species	*Eigen & Schuster*	1979
20	Radiation Gradient Reducing Systems	*Ulanowicz & Hannon*	1987
21	Coherent Self-organizing Structures	*Schneider & Kay*	1995
22	Biological Macromolecules	*Cantor & Schimmel*	1997
23	Localized Open Dissipative Structures	*Chin*	1999
24	Emergent Chemical Systems	McFadden	2000
25	Open Coherent Non-Equilibrium Spacetime Structures	*Chaisson*	2001
26	Supramolecular Formations	*Gladyshev*	2002
27	**Human Molecules**	*Sterner & Elser*	2002
28	Low-Entropy Information Processing Systems	*Chen*	2005
29	Self-Sustained Evolving Chemical Systems	*Hazen*	2005
30	**Human Molecules**	*Thims*	2007

While these definitions appear different, each is based on the same argument, namely that the human organism is a large animated *xy*-element molecule. In sum, knowing that the human organism, technically, is a large molecule, the basic definition of *human chemistry* is the study of human molecules and the structures they unite to form.[54] Next, building on this premise, we will define the surface of the earth to be human molecular substrate:

> **Substrate** – the catalyst surface on which human molecules react or the base on which an organism lives; also referring to a substance such as agar or growing medium, as in land, that provides the nutrients for the metabolism of the organism.[55]

Just as clay crystals at the bottom of tidal flats and estuaries, for instance, are postulated to have been the first templates, or structural patterns, for protein synthesis, so to by analogy was Pangaea, i.e. the hypothetical land area believed to

have once connected the landmasses of the southern hemisphere with those of the northern hemisphere, the original template for human molecular synthesis.[56]

Human molecular symbols

To facilitate the discussion and analysis of human chemical reactions, i.e. reactions between two or more human molecules, symbols are typically used in chemical equations to representation of the human structures involved. One of the first to use symbols to represent humans as molecules or chemical species was American computational chemist David Hwang who, in his excellent 2001 article *The Thermodynamics of Love*, utilized the following symbol choice methodology:[57]

M = male
F = female
M-F = compound

These choices, however, create confusion: 'M' is also the symbol for Mega and 'F' is the symbol for fluorine. To alleviate this situation, when naming atoms, elements, or molecules a standard naming methodology or convention is typically followed for choosing representative abbreviations. First, use the initial letter as a capital and the second letter as a lower case, unless that symbol has already been used for an element, in which case one takes the next letter, and so on. Second, some names come to us from antiquity, such as: gold *Au*, from the Latin word *aurum*, which means 'glow of sunrise', or tin *Sn*, from the Latin word *stannum*, which may be derived from the Sanscrit word *stan*, which means 'hard', etc. Third, some common elements have single letter abbreviations, as: carbon *C*, hydrogen *H*, oxygen *O*, etc. Using this format, subsequently, we will smartly subdivide human molecules into three basic groups:[58]

Mx = male human molecule (a man)
Fy = female human molecule (a woman)
Bc = immature human molecule (a baby or a child)

In terms of how we arrived at these three specific human molecule symbol choices, a rather lengthy search of literature, shows there to be no 'claimed', or pre-defined, or specifically chosen symbols for these molecules. Essentially, there is no blueprint.

In this direction, using 'B' = baby, 'I' = infant, or 'C' = child assignments conflict with *B* = Boron, *I* = Iodine, and *C* = Carbon. Next in line, if we used the initial letter as a capital, and the second letter as the lower case, this would give us, for example *Ma* (male), *Fe* (female), and *Ba* (baby); but as we know 'Ma' is short for Mama, *Fe* = Iron, and *Ba* = Barium. Next, we would be wise to keep the initial letter as: *M*, *F*, and *B*, but to choose new lowercase letters. Since the letters 'x' and

'y' seem intuitively correct, owing to their basic connection to twenty-third human chromosome rule, which determines the sex of the individual according to the rule: *XY = Male* and *XX = Female*; then we will lean towards the letters 'x', 'y', and 'c' (child) for the choice of our lower case letters. For our final assignment, however, we will use the letters x and y in a reverse manner as indicated above.[59]

In other variations of human reactions, such as in more advanced bonding rearrangements, bond formations, bond dissolutions, etc., other human molecular symbols can be used, as shown below, as are found in previous publications:[60]

Mx = Male	Up = Paternal Uncle	Gf = Girlfriend
Fy = Female	Um = Maternal Uncle	Fc = Close Friend
MxFy = Bonded Couple	Ap = Paternal Aunt	F = Friend
Bc = Baby or Child	Am = Maternal Aunt	Fd = Distant Friend
Fa = Father	Cp = Paternal Cousin	Nr = Neighbor
Ma = Mother	Cm = Maternal Cousin	W = Work or Job
Sb = Sibling	Ne = Niece	Sc = School
Gf = Grandfather	Nw = Nephew	Si = Society
Gm = Grandmother	Bf = Boyfriend	Ob = Objective

When countable social aggregates form, such as social cliques, networks, or rings, etc., the subscript shorthand method is advisable, where the subscript represents the number of units present. The shorthand Fy_2, for instance, means that two female human molecules are present in the unit, just as in H_2 where the '2' means that two atoms are present in the unit.

In 1995, to use a real example, American sociologists Peter Bearman, James Moody, and Katherine Stovel mapped the sexual attachments and resultant human molecular formations of 832 students at a U.S. mid-western public high school with a population of about 1,000 students.[61]

The resulting connective structures were plotted out as nodal structures, of various configurations. In each diagram, each nodal point is one human molecule and the ties between each node are genetic-potential sexual chemical bonds, in which there occurred some type of fluid exchange. Specifically, the diagrams were a result of a survey in which students were asked to identify their sexual and romantic partners in the past 18 months from a roster of students attending the school.[62]

In their findings, aside from many two-, three-, and four-chain human molecular complexes, approximately ½ of sexually active population, 573 students, had assembled into a ring-shaped, 288-person, $Mx_{144}Fy_{144}$, sexual social cluster, having many side chains. This large hecta-human molecular sexual relationship ring is similar in basic stability tendencies to that of the simple 6-chain benzene C_6H_6 ring.

For mega-molecular structures such as groups, corporations, states, or countries, etc., appropriate Latin prefixes or suffixes, symbols, and multiplication quantifiers are added as needed, such as, for example:

Di-human-ide molecule – 2 humans bonded in a relationship or marriage, etc.
Tri-human-ide molecule – 3 humans bonded in a relationship, association, or family.
Deca-human-ide molecule – 10 humans bonded in a group
Hecta-human molecule structure – 10^2 humans bonded in a system.
Kilo-human molecule structure – 10^3 humans bonded in a corporation.
Mega-human molecule structure – 10^6 humans bonded in a society.
Giga-human molecular structure – 10^9 humans bonded in a worldly-community.

The suffix *'–ide'* signifies a molecular compound or structure usually derived from or related to another, usually specified, compound or structure.[63]

To summarize, the key point to remember here is that the human organism is a reactive 26-element molecule. French philosopher Rene Descartes coined the term 'molecule' in the 1620s. French historian Hippolyte Taine, in 1869, was the first to coin the term 'human molecule'. In 1919, American physician George Carey was the first to state that the human body has a molecular formula. In recent years, the concept of the human molecule has caught on; in the last two years, several authors have begun to utilize the human molecule construct in publication.[64] Lastly, in tribute to Kant's categorical machine imperative, on November 02, 2006, Texas photographer Pierre Rousseau posted the following photograph (with caption) online:[65]

The constant flow of *human molecules*

In this chapter, we have shown definitively that the human being is a molecule, no different than any other molecule in the universe. Moreover, herein, as a first approximation, we have shown two results of the calculation of the human molecular formula.[65] This reality, that a human is a molecule, takes a bit of getting used to. The following closing chapter will give a gist overview of the basics of evolution from the hydrogen atom to the human molecule.

9 – Molecular Evolution:

"The body contains only 2 percent of the atoms that were spinning in it one year ago."

George Harrison, *Science Writer*[1]

One of the most tenuous topics in science is that of evolution.[2] In surveys conducted in 2005, people in the U.S. and thirty-two European countries were asked whether to respond 'true', 'false' or 'not sure' to this statement: 'human beings, as we know them, developed from earlier species of animals.' The United States had the second-highest percentage of adults who said the statement was false and the second-lowest percentage who said the statement was true. Only adults in Turkey expressed more doubts on evolution. In Iceland, 85 percent agreed with the statement.[3] In sum, everyone wants to know how, why, and where human life fits in the grand scheme of time and the growth or evolution of the universe, but there is not yet uniform agreement as to how, why, and where this fit occurs.

The study of the process of evolution, from the big-bang to the present, is called *cosmic evolution* or 'universal evolution', the scientific study of universal change.[4] The central focus of cosmic evolution is to synthesize the many varied changes involved in the assembly and composition of radiation, matter, and life throughout the history of the universe.[5] The regulatory process of cosmic evolution, according to American astrophysicist Eric Chaisson, is governed 'largely by the laws of physics, particularly those of thermodynamics.'[6]

In short, about 13.7 billion years ago, the early universe exploded into existence through a yet unknown expansion process.[7] About 9.1 billion years later, the young earth began to form from an accretion disc of elemental matter revolving around a new sun. Over the next half a billion years, the surface of the earth cooled enough to allow crust to solidify. Soon thereafter, the atmosphere and the oceans formed. In time, life emerged. This evolution picture, however cogent it may be, is incomplete.

The errors in this terse outline are the misuse of the anthropomorphic term 'life' and the dependence on the idea of 'emergence'. Technically, the earth system, including the contents of the biosphere, is a 92-element, continuously-stirred, variably-spinning, thermally-warmed, chemical tank reactor (CSTR) that has been reacting and transforming, non-stop through a thermodynamically-directed, punctuated mechanism of planetary chemical evolution.[8] The central words in this chemical process are *coupled* and *continuous*. The reactions don't stop and they didn't start on a particular day; as the following evolution table shows:

Element Count	Molecular Evolution Table	Name	Date
N/A	*Fermions:* e^-, ν_e, u, d, μ^-, ν_μ, c, s, τ^-, ν_τ, t, b *Gauge bosons:* g_{ab}, γ, W^+, W^-, Z^0, G	Elementary Particles	13.7 BYA
1	H, He-3, He-4, Li	Atoms	3E5 YAB
1	H_2	Hydrogen	
2	H_2O	Water	2E8 YAB
3	CH_4O	Methanol	
4	CH_4ON_2	Urea	4.6 BYA
5	$C_{10}H_{16}O_{13}N_5P_3$	DNA	
6	$C_{21}H_{36}O_{16}N_7P_3S$	Coenzyme A	
7	$C_4H_3O_2NS_2NaI$	mol-7	4.4 BYA
8	$C_{20}H_{22}O_7N_2SNaIPt$	mol-8	
9			
10	$C_{E5}H_{E5}O_{E4}N_{E4}P_{E2}S_{E2}Ca_{E2}K_{E2}Cl_{E2}Na_{E2}$	Intermediate	4.2 BYA
11			
12	$C_{E7}H_{E7}O_{E6}N_{E6}P_{E4}S_{E4}Ca_{E4}K_{E3}Cl_{E3}Na_{E3}Mg_{E2}Fe_{E2}$	Pro-bacteria	4.0 BYA
13			
14			
15	$C_{E10}H_{E10}O_{E10}N_{E9}P_{E8}S_{E8}Ca_{E8}K_{E6}Cl_{E6}Na_{E6}Mg_{E6}Fe_{E5}$ $Si_{E4}Mn_{E2}Co_{E2}$	Prokaryote (Bacteria)	3.85 BYA
16			
17			
18	$C_{E16}H_{E16}O_{E16}N_{E15}P_{E14}S_{E14}Ca_{E14}K_{E12}Cl_{E12}Na_{E12}Mg_{E12}Fe_{E11}Fe_{11}$ $Si_{E10}Cu_{E9}Mn_{E8}Se_{E8}Co_{E7}$	Pre-Aquatic Worm	2.6 BYA
19			
20			
21			
22	$C_{E22}H_{E22}O_{E22}N_{E21}P_{E20}S_{E19}Ca_{E20}K_{E18}Cl_{E18}Na_{E18}Mg_{E18}Fe_{E17}Fe_{17}$ $Zn_{E16}Si_{E16}Cu_{E15}I_{E14}Mn_{E14}Se_{E14}Mo_{E13}Co_{E13}V_{E12}$	Fish	0.7 BYA
23		Reptile	350 MYA
24	$C_{E26}H_{E26}O_{E26}N_{E25}P_{E24}S_{E23}Ca_{E24}K_{E22}Cl_{E22}Na_{E22}Mg_{E22}Fe_{E21}Fe_{21}$ $Zn_{E20}Si_{E20}Cu_{E19}B_{E19}I_{E18}Mn_{E18}Se_{E18}Cr_{E18}Mo_{E17}Co_{E17}V_{E16}$	Old World Monkey	30 MYA
25		*A. Afarensis*	5.0 MYA
26	$C_{E27}H_{E27}O_{E27}N_{E26}P_{E25}S_{E24}Ca_{E25}K_{E24}Cl_{E24}Na_{E24}Mg_{E24}Fe_{E23}Fe_{23}$ $Zn_{E22}Si_{E22}Cu_{E21}B_{E21}I_{E20}Sn_{E20}Mn_{E20}Se_{E20}Cr_{E20}Ni_{E20}Mo_{E19}Co_{E19}V_{E18}$	Human (*H. Sapiens*)	0.2 MYA
27			
28		Evolution	

This molecular evolution table shows some of the basic building blocks (reactants) involved in evolution, from the hydrogen molecule H_2 to the human molecule *Mx* or *Fy*, over the last 13.7 billion years.[9] In short, human species evolved from hydrogen species and there is a seamless continuity in the evolution lineage.

> “In respect of man’s anatomical and physiological equipment a continuity in structure with that of other species is unquestionable. In respect of his behavioral equipment continuity of structure may be less evident, but were continuity to be totally absent all we know of man’s evolution would be contradicted.”
>
> – *John Bowlby*, British Developmental Psychologist [1969]

The first row shows the basic matter particles, called *fermions*, and force particles, called *gauge bosons*, found at the initial high-temperature reaction phase of the exploding universe.[10] The second row shows the three types of atoms, hydrogen *H*, helium *He*, and lithium *Li,* that had energetically assembled during the first 300 seconds to 300,000 years after the bang (YAB).

The galaxies’ first stars, which formed only 200 million years after the bang, consisted almost entirely of hydrogen and helium. Through a process of nuclear fusion, in which *H* and *He* were fused, these stars slowly made the heavier elements: from carbon *C* to calcium *Ca*. In time, large stellar molecular clouds, heated by stars embedded within it, began to produce the galaxies’ first molecules, those such as: methane (CH_4), ammonia (NH_3), water (H_2O), hydrogen sulfide (H_2S), hydrogen cyanide (HCN), carbon monoxide (CO), carbon dioxide (CO_2), nitrous oxide (N_2O) and phosphate (PO_4^{3-}).

Shortly thereafter, these sets of small molecules reacted to produce many larger 3-element and 4-element molecules, such as: propylene (C_3H_6), β-carotene ($C_{40}H_{56}$), α-pinene ($C_{10}H_{16}$), vanillin ($C_8H_8O_3$), camphor ($C_{10}H_{16}O$), retinol ($C_{20}H_{30}O$), glucose ($C_6H_{12}O_6$), sucrose ($C_{12}H_{22}O_{11}$), oleic acid ($C_{18}H_{34}O_2$), dopamine ($C_8H_{11}O_2N$), cocaine ($C_{17}H_{21}O_4N$), glycine ($C_2H_5O_2N$), alanine ($C_3H_7O_2N$), and tyrosine ($C_9H_{11}O_3N$). Soon, bigger and more complex 5-element molecules were formed, such as the pigment chlorophyll ($C_{55}H_{72}MgN_4O_5$), RNA ($C_{10}H_{12}O_6N_5P$), and DNA ($C_{10}H_{16}O_{13}N_5P_3$), which in turn evolved and reconfigured into 6-element molecules, such as coenzyme A ($C_{21}H_{36}O_{16}N_7P_3S$); these, similarly, evolved into larger more complex 7-element molecules, and so on. Eventually, large 26-element molecules called humans were formed about a medium-sized star called the sun, a reactionary event that began to occur about 200,000 years ago.

In short, life is reactionary process of molecular evolution governed by the four laws of thermodynamics.[11] In addition, if we define life to be any type of animate molecule, then the essential point at which we might say ‘earth life’ technically began, would be the exact second the sun ignited. Even before this, however, atoms and molecules would have been reacting, evolving, and transforming in the pre-sun aggregate of gaseous matter. The sun’s current age, determined using algorithmic computer models of stellar evolution and nucleo-cosmochronology, is thought to be about 4.57 billion years.[12] In this manner, molecular evolution, within the

delineating Kármán line region, which is the 62 mile-high space-earth boundary demarcation, above the earth's surface, can be written in simple chemical shorthand as such:

$$\bullet\bullet\bullet D \rightarrow E \rightarrow M_1 \rightarrow M_2 \rightarrow M_3 \rightarrow M_4 \rightarrow M_5 \rightarrow M_7 \rightarrow M_8 \rightarrow M_9 \bullet\bullet\bullet$$

Here, D is the accretion disc of elements, E is the solidified earth, M_1 is a distinct species of molecular structure, found within the Kármán line boundary, M_2 is a distinct species evolved from M_1, M_3 is a species evolved from M_2, and so on, and in which each arrow represents a specific, energetically-defined, chemical reaction or series of coupled chemical reaction mechanisms. In other words, to go through one example of an *evolution lineage*, about 4.3 billion years ago an 8-element molecule M_N, which itself had formed from a previous species of 7-element molecules M_{N-1}, reacted with other molecules of its own kind, via chemical mate recognition systems, to eventually form a new species of 9-element molecules M_{N+1}.[13] In time, these species of 9-element molecules would have reacted in a continuous manner to atomically-evolve into species of 10-element molecules and then eventually into a 12-element pro-bacterial species, which we might call M_1, a social collective that existed 4.0 billion years ago. Soon thereafter, these pro-bacterial species would have reacted further with similar species of their own kind to eventually form species M_2 and then eventually a prokaryote species M_{2+X}, such as bacteria, where X would be a whole number related to the number of intermediate species reaction steps involved in the evolution.

These M_{2+X} molecular species would eventually react to form species of aquatic worms M_{3+X}, who in turn gave way to various evolved species of fishes M_{4+X}, which soon gave way to land-walking species of fishes M_{5+X}, that eventually transformed into species of reptiles M_{6+X}, which gave way, about 245 to 66 million years ago, to mammals M_{7+X}. These species of mammals soon evolved into small dexterous tree shrews M_{8+X}, which gave way to old world monkeys, M_{9+X}, a chemical transition that occurred 30 million years ago. In time, collective social systems of these reactive old world monkeys transformed into systems of chimpanzee species about 7 million years ago. About 5.5 million years ago, mating systems of chimpanzee species eventually reacted to form evolved species of hominids. The hominid line, of which *Homo sapiens*, the anatomically modern species of humankind, is the culmination, separated from the ape social system between 4 and 5 million years ago, at which point the two distinct species had developed separate mate recognition systems.[14]

The first hominid to be considered human, *Homo habilis*, appeared about 2.4 million years ago. About 1.9 million years ago *Homo habilis* was replaced by *Homo erectus*, with a brain size about two-thirds that of modern humans. Over the next million years this proportion grew to three-quarters, the brain evolving rapidly as the climate fluctuated from dry glacial periods to warmer, moister inter-glacial periods.[14]

Homo erectus was the first hominid to live outside of Africa. As early as 1.8 million years ago the *Homo erectus* population had spread through tropical south and southeast Asia and colonized temperate areas of Europe and northern China. In this period, the isolated *Homo erectus* populations began to evolve in different ways, especially after the 500,000 years ago mark. In Africa, archaic humans evolved into anatomically modern humans, *Homo sapiens*, who began to appear about 135,000 years ago in the East African Rift valley.[14]

All modern day human beings are direct descendents of these Rift valley Homo sapiens. In particular, according to genetic evidence, namely lineage tracking of the Y-chromosome, a marker that only transfers down the male line, it is known that every single person alive today is a direct descendent of a single man who lived in Africa 60,000 years ago. In time, the African population, descendent from this man, began to split. Estimates indicate that the African / East Asian split occurred 41,000 years ago, the African / European split occurred 33,000 years ago, and divergence between the Europeans / East Asians occurred 21,000 years ago.[15] By the end of the Ice age, about 10,000 years ago, only some oceanic islands, Antarctica, and some parts of the high Arctic remained completely uninhabited by humans.[14]

This overall evolution reaction description, of course, is a huge simplification for what is invariably a more immense chemical reaction mechanism, involving billions of various intricate evolution reactions. In more technical detail, numerous variations of large-scale, hydrogen-molecule to animal-sized, molecular reactions would have been directly involved, those such as isomerization, combination, decomposition, single displacement, and double displacement reactions, etc., many of which would have been energetically coupled.

The generic, albeit incorrect, current theory of the origin of life, however, holds that once upon a time, three or four billion years ago, lightning struck a puddle of water containing a kind of warm chemical chicken broth and triggered the formation of amino acids, the building blocks of life.[16] This interesting warm pond picture originated from a 1871 letter written by English naturalist Charles Darwin to English botanist Joseph Hooker wherein Darwin made the suggestion that the original spark of life may have begun in a 'warm little pond, with all sorts of ammonia and phosphoric salts, lights, heat, electricity, etc. present, so that a protein compound was chemically formed ready to undergo still more complex changes.'

In 1936, improving on Darwin's warm pond model, Russian biochemist Aleksandr Oparin demonstrated that the formation of living tissue was preceded by a long and gradual chemical evolution involving nitrogen, oxygen, and other compounds. The evolution process, according to Oparin, would have passed through three distinct chemical phases: from inorganic, to organic, to biological chemistry. Oparin's model is a step up from Darwin's; however, dividing chemistry into phases is not the most intuitive way visualize things. In other words, chemistry is chemistry. Human chemistry is no different than biological chemistry, organic

chemistry, or inorganic chemistry, it's all the science of reactions between molecules.

In his *The Origin of Life*, Oparin argued that a 'primeval soup' of organic molecules could be created, from a system of inorganic molecules, in an oxygenless atmosphere through the action of sunlight. These would combine in ever-more complex fashion until they dissolved into what he called a coacervate droplet. These droplets would grow by fusion with other droplets, and reproduce through fission into daughter droplets, and so have a primitive metabolism in which those factors which promote cell integrity survive, whereas those that don't became extinct.

Curiously, not much on this picture has changed up to the present. In September of 2000, for example, a 'What is Life?' conference was held in Modena, Italy, which was attended by about a hundred scientists, philosophers, and theologians. Between the scientists, a debate erupted in regards to what the first form of life was. One expert on lipid molecules argued that life began with the formation of the first semipermeable lipid membrane, a structure that encases cells. A noted metabolism researcher argued that life began with the first metabolic cycle, thus giving cells the power to convert energy and atoms into useful molecules. The molecular biologists were adamant that that the first living entity must have been an RNA-like genetic system that carried and duplicated biological information. One mineralogist even threw out the wild card that the first life was a self-replicating mineral.[17]

These elementary descriptions, however pleasing to the mind they may be, are incongruent with modern standard molecular evolution tables.[9] To elaborate on this, presently, between the hard-sciences, namely chemistry, mathematics, and physics, and soft-sciences, namely biology, psychology, and sociology, there lies a chasm of incongruence so prevalent in acceptance that it seemingly passes unnoticed even under the most astute of observation.[18] On one hand, we preen ourselves on appeal of biology and find there to be a genetic 'struggle' for existence; on the other, we entrench ourselves in the exacting fortitude of chemistry and find there to be a graceful symphony of exacting chemical reactions. In other words, on the biological or psychological side of the fence, molecules are thought to be in a *struggle*, and on the chemical side of the fence, molecules *react*. Only one of these suppositions can be correct.

To suppose, for example, that the oxygen atom *O* struggles to exist as it interacts with hydrogen *H* to form water H_2O, is comparable to saying that when a raindrop, i.e. an aggregate of water molecules, falls from a saturated cloud to the barren earth that it is in a sense 'struggling' along its path. Both statements are near to absurd. The raindrop falls because it is gravitationally 'forced' to fall. The oxygen atom reacts because it is electromagnetically 'forced' to react. There is no struggle. All movements in the universe occur because they are forced to occur. There may, at times, however, exist a certain conflict, ambivalence, indecision, or resistance of forces, but these are always forces.

A second point to this evolution chasm lies within the 'origin of life' question. According to standard references, such as Britannica, the majority of the scientific hypotheses of the origin of life will fall into one of three categories: (a) *life* spontaneously and readily arises from nonliving matter in short periods of time, today as in the past, (b) *life* is coeternal with matter and has no beginning; life arrived on the earth at the time of the origin of the earth or shortly thereafter, or (c) *life* arose on the early earth by a series of progressive chemical reactions, which may have been likely or may have required one or more highly improbable chemical events.

As to the first option, the idea that life spontaneous generates is an outdated concept by many centuries. Egyptians, as early as 3000 BC, had noted the spontaneous appearance of beetles from moist camel dung mounds following three days of solar incubation and also correlated the spontaneous appearance of mice with the annual occurrence of the Nile flood, thus reasoning that mice were begotten from wet mud and beetles from moist dung. Similarly, Aristotle, in third century BC, noted that aphids spontaneously appear after dew falls on plants and that fleas derive from putrid matter. This type of antiquated logic continued onward for nearly two-thousand-years until exact scientific experimentation began to disprove each theory. The downfall of the various spontaneous generation theories, in finality, was Italian physician Francesco Redi's 1668 experiment where he showed that the spontaneous generation of maggots from rotten meat was due not to any type of hypothetical generation, but rather due to the simple process whereby flies lay eggs in the meat.

As to the latter generic origin of life options, certainly life arose by a series of progressive chemical reactions, this is obvious; but that life is coeternal with matter and has no beginning is a tricky issue.[19] The real answer, of course, is that the first molecule in the universe was the hydrogen ion molecule H_2^+ (a bonded system of two protons and one electron), energetically formed about thirteen billion years ago, from high-speed systems of quarks and electrons, after the early hot universe cooled enough to have allowed atoms to form, the rest is chemical reaction mechanism history.[20]

Compounding this picture, for many, however, is the perceived energy problem. That is, for an earth-bound biological molecule to form, an initial source of energy, different from that of standard sunlight, it is argued, would have been needed to ignite, spark, or start the imaginary 'original' chemical reaction. Hypothetical initial energy sources include: electricity from lightning activity, heat from deep sea thermal vents, gravitational energy from earth quakes, kinetic energy from meteor showers, warmth from volcanic activity, etc. Moreover, because fossil evidence indicates that bacteria existed some 3.85 billion years ago, most have argued that life began during these years when the right combination of chemicals came into contact with the right energy source. Interestingly, most of these theories seem to imply that the thermal energy from the sun has nothing to do with it? This is certainly wrong.

Another salient point of debate, which is silently incongruent, is that if humans are indeed molecules, and if humans are alive, then by logical extrapolation, either all molecules are alive or no molecules are alive or only certain types of molecules can be appropriately defined as being alive. This is an interesting puzzle. Life from a human chemical perspective is best defined as series or sets of evolving parallel biochemical reactions. The meaning of life, subsequently, is to react. On this definition, we might ask: what does it mean to react? Or, if something reacts, does that mean it is alive? These are fascinating questions with discernable answers.

The basic answer, is that it depends on a point of view. If one were a quark, for instance, then one would likely define other quarks to be alive. If one were a 36-element form of atomic-intelligence on a far distant planet, then one would *not* likely define human molecules to be alive, in an equivalent sense to themselves, similar to how humans view 16-element bacteria molecules. In human chemistry, we will define life to be a *measure of reactivity*. In other words, the rate of the reaction characterizes life. This type of classification again, however, comes down to a matter of point-of-view semantics. The advanced perspective, for example, would define all types of molecules, reacting or not, to be boson-driven atomic structures, the internal nature of which, would be classified a type of sub-atomic life (or sub-atomic dynamics).[21]

A fifth area of heated debate is the *selfish gene theory*, namely that some believe RNA was the first form of life, that RNA molecules reacted to form DNA molecules, and that DNA molecules, in which a strand of DNA is called a 'gene', are a type of selfish molecule, in which each gene, or segment of DNA, is only concerned with it's own welfare or advantage in life in disregard of other genes or molecules.[22] This phenomena clearly does not exist in chemistry, but is illogically believed to exist in biology. In other words, if an RNA molecule is, so-to-say, a 'selfish' molecule, then one also has to prove that every other molecule in the universe, such as a propylene C_3H_6 molecule, is selfish. This type of proof cannot be found. All molecules act and behave according to the laws of chemistry, namely quantum chemistry and chemical thermodynamics.[23]

The selfish gene theory, however, is popular and has interesting points about it. The theory itself, began with British evolutionary biologist William Hamilton's 1964 mathematical argument that the natural selection of 'selfish genes' can favor altruistic behavior among relatives.[24] Namely that, we each will help our extended family members, brothers, sisters, cousins, aunts, second cousins, etc., relative to the fractional proportions of genes we have in common with them.

In 1966, in relation to Hamilton's fractional gene theory, American evolutionary biologist George Williams, in his book *Adaptation and Natural Selection*, postulated that the gene itself is the basic unit of natural selection.[25] Specifically, Williams reasoned that 'the essence of the genetical theory of natural selection is a statistical bias in the relative rates of survival of alternatives, i.e. genes, individuals, etc. The

effectiveness of such bias in producing adaptation is contingent on the maintenance of certain quantitative relationships among the operative factors. One necessary condition is that the selected entity must have a high degree of permanence and a low rate of endogenous change, relative to the degree of bias, i.e. differences in selection coefficients.'[26] Williams argued that 'the natural selection of phenotypes cannot in itself produce cumulative change, because phenotypes are extremely temporary manifestations.' In other words, according to Williams, only the natural selection of genotypes can produce cumulative change.

The tipping point for the start of the various RNA-DNA evolution theories, was Austrian physicist Erwin Schrödinger's 1944 book *What is Life?* In this book, the very same book that famously postulated that 'life feeds on negative entropy', we are presented with the argument that every organism contains a 'hereditary substance' consisting of a few atoms. Moreover, the 'gene', according to Schrödinger, is a huge molecule, capable only of discontinuous change, which consists in a rearrangement of the atoms and leads to an isomerization. This atomic rearrangement, according to Schrödinger, will only affect 'a small region of the gene' and that 'a vast number of different rearrangements may be possible.' In addition, 'the energy thresholds, separating the actual configuration from any possible isomeric ones, have to be high enough, compared with the average heat energy of the atom, to make the change-over rate a rare event.' Schrödinger identifies these 'rare events' with spontaneous mutation.

In 1953, having been stimulated by Schrödinger's revolutionary ideas about this hereditary substance, biologists Francis Crick and James Watson discerned the double-helix, three-dimensional, atomic structure called deoxyribonucleic acid, i.e. DNA. This heredity molecule soon came to be known as the 'secret of life'.[28] In 1962, Crick and Watson were awarded the Nobel Prize for their 'discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material.'[28]

Since this discovery, then, DNA has been known as the main physical substrate to genetic information, and that it is capable of high fidelity replication through many generations. In this manner, a particular sequence of DNA, i.e. a gene, can have a high permanence and a low rate of endogenous change, and thus may function as unit of selection. The icing to the cake of this theory came in 1976, when British ethologist Richard Dawkins, in his book *The Selfish Gene*, proclaimed, in a manner similar to Descartes' *animal machine*, that humans are 'survival machines: robot vehicles blindly programmed to preserve the selfish molecules known as genes.' In short, the selfish gene theory, according to Dawkins, is essentially Darwin's theory of natural selection, but from a gene's-eye view of nature, in which all life forms are machines created by genes.[29] It is along these lines of reasoning that *The Selfish Gene* went on to become a million-copy international best-seller.

The selfish gene theory, however popular it may be, is far from perfect. Firstly, the basic weakness in this theory, aside from the off-idea that molecules are selfish, is that prior to the formation of RNA, the selfish gene theory falls apart. Current estimates indicate that bacteria, which contains RNA, may have existed about 3.85 billion years ago.[30] Hence, between the years 13.7 to 3.5 billion years ago there were no genes that we know of yet atomic and molecular evolution still took place.

Another point of inconsistency is that humans, for example, are comprised of 26 distinct elements. Hence, 21 of these elements, according to the selfish gene theory, are subservient to the elements carbon, hydrogen, nitrogen, oxygen, and phosphorus, the atoms of genes. In other words, are we to believe that 5 of the total 92 naturally occurring elements in the system of the earth control or create the behaviors of the rest? This is not the case, the bonding tendencies of carbon, i.e. tetra-valence, nitrogen, i.e. tri-valence, and oxygen, i.e. bi-valence, for example, do in themselves create and control the rest of the biosphere. In short, the selfish gene theory oversimplifies the relationship between genes, the organism, and the environment. The science of genetics, however, is certainly a fruitful line of research, but as far as evolution is concerned far too much importance is placed on segments of DNA as being the say-all of molecular evolution life. In short, the selfish gene theory is interesting and a close approximation, but the human dynamics and chemical life of molecules are more complicated than this.

Connected to this theory, is the idea that RNA was first form of life. The 'RNA world hypothesis', proposed originally by American micro-biologist Carl Woese in his 1968 book *The Genetic Code*, argues that RNA, i.e. ribonucleic acid, was the first life.[31] These little RNA molecules, it is argued, evolved into DNA and the protein world of today. The RNA molecule itself, however, is a complex, high-molecular-weight, 5-element macromolecule, arranged in the form of nucleotide chains with an approximate molecular formula of $(C_{10}H_{12}O_6N_5P)_Z$, where Z is the number of nucleotides in the chain. To form this complex macromolecular structure, this RNA molecule would have had to have evolved from a much older pre-RNA chemical species, and this pre-species itself would have had to have evolved from a more rudimentary, less complex species before that, and so on. As such, if we are to naively believe that the 5-element RNA was the first from of life, then we would also have to believe in the following backwards logic:

$C_4H_7O_4N$ (aspartic acid) – not alive
$C_{10}H_{12}O_6N_5P$ (ribonucleic acid) – alive
$C_{21}H_{36}O_{16}N_7P_3S$ (coenzyme A) – more alive

This type of reasoning, in which small 4-element molecules, such as aspartic acid, a crystalline amino acid found especially in plants, are not alive, whereas 5-element molecules, such as RNA, are alive, is clearly ridiculous. The hypothesis put forward

herein, to reconcile these areas of theoretical inconsistency, is that the human organism is 26-element molecule and that it as well as all other multi-element molecules are dynamic atomic structures found within a 92-element, heat-fluxed, environment, which together react, form, and break bonds, evolve, and reproduce according to the four laws of thermodynamics. Moreover, there is no such reality as there being a specific energy-filled 'spark day' in earth's past in which molecules suddenly became lifelike, alive, or imbued with life, etc., as it is currently believed.

One example of how genes, biological structures, and thermodynamics relate to each other is the relationship between troop structure in Gorilla social systems and the neurotransmitter serotonin, the so-called 'confidence chemical'. If, for example, the alpha male of a troop dies or leaves, for whatever reason, this creates a stability gap in the social structure of the troop, which instills feelings of social uncertainly or weakness. In thermodynamic terms, the structural gap will force the troop system to evolve or reconfigure into a new bonding arrangement, which will correlate to a decrease in the Gibbs free energy of the system. In other words, in order for the group to keep 'working' properly, someone will have to assume the role of the alpha male. Again, in chemistry Gibbs free energy is a measure of this working energy.

To remedy this situation, system sensory stimuli in the troop, e.g. feelings of loss, mental weakness, social uneasiness, insecurity, etc., conveyed to each member subtly through unconscious situational language, will 'force' the next lower ranking beta male into the alpha role. To actuate this process, various sensor stimuli will activate select serotonin producing portions of the beta male's genome, i.e. switch them on, such that within a few days the beta male's confidence will rise, and he will fill the role of the alpha male.[32] In sum, system constraints reconfigure the atoms and molecules in the system towards an evolution path that will tend to lower the free energy of the system, i.e. stabilize it and thus keep it working. In this process, it was the initial photonic stimulus (trigger-action) to the sensor system of the initial alpha-male, causing (forcing) him to leave (or die), that initiated the system reaction, not each genes' self-serving purpose.

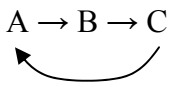
Contrary to this, is the current line of reasoning in the various evolution theories in which, for example, that bacterial life spontaneously arose from non-life about 3.85 billion years ago. From a biologist's perspective, Lynn Margulis, in the preface to her 1995 book *What is Life?,* co-written with Dorian Sagan, states 'Darwin taught us that all of life is descended from a single common ancestor.' On this, Margulis then presents the hypothesis that life evolved via an evolutionary mechanism of bacterial fusion occurring about 3.9 billion years ago, in which two separate bacteria united by a process symbiogenesis, i.e. two bacteria began to live symbiotically together. In chemical terms, this would be a combination reaction followed by a substrate-mediated transformation reaction:

$$B_1 + B_2 \rightarrow B_1B_2 \rightarrow B_3$$

According to this logic, the first entity of life on earth was a single magnificent little bacteria B_3 scooting about alone and autonomously in a world filled with non-living chemical precursors. This single bacterium, then, theoretically, split into two; these split into four, and so on. When taken on face value this logic seems to make a great deal of intuitive sense. The little bacteria, born from non-living chemical precursors, would subsequently grow, evolve, and transform into humans given time and the proper energy source. The problem here, essentially, is that a bacterium is a 15-element molecule; hence, prior to the formation of bacteria species there would have existed various reactive rudimentary species of 14-element pro-bacteria, and before that 13-element species, etc. In other words, are we to assume that these 'missing' 14-, 13-, and 12-element species were in some way dead?

Similarly, but more accurate from a chemical perspective, in the 1995 book *At Home in the Universe*, complexity theorist and biochemist Stuart Kauffman tells us 'most of my colleagues believe that life emerged simple and became complex. They picture nude RNA molecules replicating and replicating and eventually stumbling on and assembling all the complicated chemical machinery we find in a living cell. Most of the colleagues also believe that life is utterly dependent on the molecular logic of template replication, the A-T, G-C Watson-Crick paring.' Here Kauffman is pointing out the difficulty many have with the idea that RNA was the first life form.

The hypothesis Kauffman puts forward to resolve this issue, is that whenever a mix of atoms and molecules accumulate, there is a small chance that an autocatalytic reactive system, which can be thought of as a rudimentary type of self-maintaining and self-reproducing metabolism, will spring forth, and from this life will emerge. He states that life, at its roots, is the property of what is called 'catalytic closure' as proffered to be found amid heterogeneous collections of reacting molecular species. An autocatalytic system is one in which the end-products of a reaction function as a catalysis for the initial-reactants, i.e. one in which the molecules speed up the very reactions by which they themselves are formed: *A* makes *B*; *B* makes *C*; *C* makes *A* again, similar to following diagram:



Autocatalytic Closure

Hence, according to Kauffmann, 'alone, each molecular species is dead. Jointly, once catalytic closure among them is achieved, the collective system of molecules is alive.' Using this logic, Kauffmann reasons that past a certain critical threshold of molecular density, a web of catalyzed reactions emerges, which can be thought of as being alive. In his own words, 'as a threshold of diversity is crossed, a giant web of catalyzed reactions crystallizes in a phase transition.' In this view, to account for the

origin of life, Kauffman tells us, 'a critical diversity of molecules must be reached for the system to catch fire, for catalytic closure to be attained.'

This model, as we see, is very close to the correct answer. In reality, however, there is no such thing as a dead molecule. Every molecule, no matter what its state, will always possess a significant internal energetic subatomic life and will also be part of some variation of planetary, stellar, or galactic-scale atomic reaction cycle.[33] Furthermore, the concept of a self-sustaining chemical reaction that 'catches fire' and actuates on its own is paramount to arguing that there is such a thing as a perpetual mobile of the second kind, an argument that was shown to be fallacious in the late 19th century.[34] It is possible, to note, however, that Kaufmann's auto-catalysis reaction scheme would have likely played a significant role in long-term evolutionary chemical mechanisms, as it certainly does presently in many basic biochemical situations, but it certainly is not the starting point.

In 2003, to summarize the prevalent origin of life viewpoint, biochemist Paul Lurquin, in his *The Origins of Life and the Universe*, states 'since the mechanisms of life are basically identical across all species, it is legitimate to assume, as a working model, that all living creatures share a common ancestor, the progenitor of all life as we know it.' Lurquin then goes on to ask 'what was this progenitor and how did it appear?' According to Lurquin, who appears to have captured the general opinion on this topic, if we trace our steps back into history we will arrive at a very specific moment in history, in which we would be able to watch the formation of a very small grand-parent entity called the *progenitor*, from which all life sprang?

Originally, Darwin used the term *ur-organism* to define this hypothetical 'first life' species, from which all other life forms presumably evolved.[35] Later Darwin's ur-organism evolved into Oparin's *coacervate*, which is a spherical aggregation of lipid molecules making up a colloidal inclusion held together by hydrophobic forces, which can be thought of as a little ball of organic matter formed by the hydrophobic and hydrophilic actions of water. Moreover, Oparin correctly argued that there is no fundamental difference between a living organism and lifeless matter.[36] Recently, scientists have come to use the term *last universal ancestor* to define the hypothetical latest living organism from which all currently living organisms descended.[37] Again, this line of reasoning is fallacious. On any standard molecular evolution table, one will never find a so-called last universal ancestor; that is, unless one humorously assigns the hydrogen ion molecule H_2^+, the smallest molecule in the universe, to be the famed last universal ancestor.

In the 2005 book *Genesis – the Scientific Quest for Life's Origin*, geologist and earth scientist Robert Hazen tells us correctly that life results whenever energy flows through a molecular system and that this energy can drive such molecular systems toward ever more levels of complexity. Life on earth, according to Hazen, is a result of energy interactions among versatile carbon-based molecules. From these carbon-based systems, according to Hazen, come the emergence of larger molecular

structures, along with the selection, concentration, and assembly of life's membranes, proteins, and genetic molecules. Eventually, according to this logic, these biomolecular structures would form self-replicating cycles, or chemical systems that could copy themselves and compete for finite and dwindling supplies of resources. Ultimately, in Hazen's view, competition between different self-replicating cycles works to trigger evolution by natural selection, and subsequently the development of life. This is a very accurate depiction.

To elaborate on this picture, Hazen cites space biologist Gerald Joyce's working definition of life:

> "Life is a self-sustained chemical system capable of undergoing Darwinian evolution."
>
> – *Gerald Joyce*, NASA Exobiology Panel [1994]

Hazen then declares, accurately, that 'any attempt to formulate an absolute definition that distinguishes life from non-life represents a false dichotomy.' The first cell did not just appear, according to Hazen, but rather arose through a sequence of emergent events, similar to how fossil records show that new evolved species have continuously emerged throughout history. First there was organic synthesis, then molecular selection and diversification, followed by increases in atomic complexity and further molecular evolution.

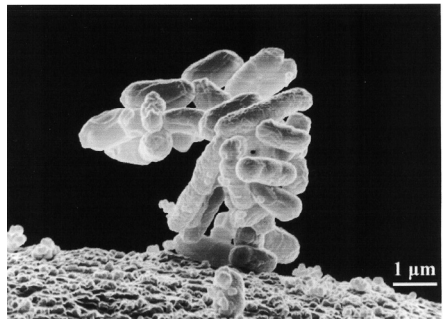
Moreover, 'what appears to us as a yawning divide between life and non-life,' according to Hazen, 'obscures the fact that the chemical evolution of life occurred in a stepwise sequence of successively more complex stages of emergence.' Hazen tells us that the basics of these steps began with a pre-biotic earth enriched with organic molecules, which then evolved to form functional clusters of molecules, perhaps arranged on a mineral surface, which assembled into larger self-replicating molecular systems that were able to copy themselves, then on to encapsulation in membranes, and finally to cellular life. Again, an excellent outline.

In 2005, in the encyclopedia *Universe*, we are told that biologists are agreed on a few basic features that distinguish life from non-life anywhere in the cosmos, in that, at a bare minimum, a living entity must be able to replicate itself, and over time, to evolve. Similarly, scientists generally agree that the beginnings of life on earth is linked to the accumulation of carbon-containing molecules and that these molecules originated from reactions of chemicals in the earth's atmosphere, stimulated by energy, such as lightning. In this early chemical system, we are given the hypothesis that: 'over millions of years the organic compounds reacted to form larger and more complex molecules, until a molecule appeared with the capacity to reproduce itself.'[38] By its nature, this 'progenitor molecule', which is characterized as a sort of rudimentary gene, became more common. Through mutations and the mechanism of natural selection, variants of this gene-like molecule would have developed more

sophisticated survival adaptations, eventually evolving into a bacterial-like cell, which, resultantly, would be the precursor to all life on earth.

This bacterial-like cell first life theory, coincidently, is remarkable similar to the view of the typical modern-day college student. In 2006, for example, when polled with the query: *'When did life begin and what did it look like?*, approximately 20% percent of people polled, aged 18-30, will give a theological-biased answer and 80% will give scientific-based answers.[39] The most common scientifically-reasoned answer is that life formed about 1-5 billion years ago in the form of a tiny cell, a single-celled microorganism, a bacteria, a small organism incased in a gel-cap, a single strand of DNA inside, or something similar to a small ameba, etc. Other more exotic answers given were that life began directly after the sun began to shine, that life began during the big universal explosion, that life began when the first water formed in the universe, or that life began 13-14 billion years ago in the form of raw energy or a combination of light and energy. One interesting answer was that life began *ad infinitum*; meaning that one cannot create something from nothing, in other words there's always been life.

From this discussion, generally, we should see that there is a perceptual blur in the dividing line between life and non-life.[40] In any event, using the current standard misconceived origin of life viewpoint, we should be able to find and label a very specific and particular organism and define it as the first life. Moreover, as we have established herein, all organisms are one of different varieties of chemical species, i.e. structures comprised of two or more atoms. Hence, in the history of the evolution of life there should have been one day in which there existed one particular little microorganism or chemical species, i.e. something visually similar to an aggregate *E. coli* bacteria, as shown below, having the properties of life:



Bacteria Molecule

$C_{E11}H_{E11}O_{E11}N_{E10}P_{E9}S_{E9}Ca_{E9}K_{E7}Cl_{E7}Na_{E7}Mg_{E7}Fe_{E6}Si_{E5}Mn_{E3}Co_{E3}$

This image is a low-temperature electron micrograph of a symbiotic cluster of about thirty *E. coli* bacteria, magnified 10,000 times.[41] Each individual bacterium in the cluster is oblong shaped. In a sense then, the above picture, according to current

scientific dogma, would be something similar to what would be the first form of life on earth. The standard evolution table, as we have discussed, however, shows this logic to be faulty.[9] In other words, it is inconceivable to think that, for example, a fifteen element molecule is in some way inherently different than a fourteen element molecule, or, for that matter, a thirteen or twelve element molecule, etc. The molecular evolution process is continuous and did not start with an amoeba, a single cell, a tiny bacterium, DNA, or RNA; atomic life started with formation of hydrogen.

The first to make this type of comparison was Hermann von Helmholtz, in a series of lectures delivered at the Carlsruhe in the winter of 1862-63, entitled 'On the Conservation of Force', where he made the comparison of a system of gas particles to that of a swarm of gnats. The particles, according to Helmholtz, probably cross one another in rectilinear paths in all directions, until, striking another particle, or against the side of a vessel, they are reflected in another direction.[42]

In late 1870s, a similar interesting molecular anthropomorphism was made by French meteorologist Antoni Poincare, in his book *On Science,* where in the chapter 'New Concepts of Matter' he made a comparison between the behavior of a cluster of midges, i.e. tiny dipteran flies, and a system of gas molecules. In modern terms, this would be a comparison between, for example, a collection of volatile carbon dioxide molecules CO_2, a system of two-element molecules, in a gaseous state to that of a collective of bees, i.e. systems of eighteen-element winged bio-molecules in an angered state.[43] A bee, in atomic composition, is a large eighteen-element molecule, no different than that of a volatile gas phase two-element molecule, such as a carbon dioxide molecule. The only inherent difference between each type of molecule is the complexity their various reactions, where complexity increases with element count.

An interesting observation in reference to the molecular evolution table comes from Italian physician Sebastiano Venturi, an expert in iodine deficiency, metabolism, and evolution research. Venturi notes that, according to his iodine research, the incorporation of atomic iodine into biological molecular structure, such as iodocarbons, may have began in *Cyanobacteria*, as a primitive antioxidant, probably about 3.5 BYA.[44] The current table, by contrast, does not list iodine *I* in the molecular formula for bacteria. In short, Venturi agrees with the structure of the molecular evolution, he only points out that further research will be needed to calculate more exact formulas and to find more exact elemental incorporation rates chronologically.

Another point of interest is that from certain known dates on the molecular evolution table, we can extract the reaction rate of elemental incorporation into living biomolecular mass. Specifically, based on the fact that many 4-element molecules exist in space as found in meteorites, e.g. cohenite $(FeNiCo)_3C$, meaning that at least four element molecules in size or greater would have existed when the earth formed, and knowing that basic fossil records indicate that 15-element prokaryote molecules,

e.g. bacteria, existed on the surface of the earth approximately 3.85 billion years ago, we can extrapolate various molecular evolution reaction rates.

In other words, if we assume that the early earth system at the exact age of 4.6 BYA, in a revolving atomic-molecular cloud-particle state, was composed of 92 elements, but that the size of all the molecules comprising its structure were only 4-element molecules or smaller, we can then show how long would it have theoretically taken an earth-bound reactive system of 4-element molecules, warmed daily by the sun and agitated daily via magnetic core rotation, to react together to form evolved or emergent systems or species of 5-element molecules. Similarly, we can figure out how many years would it take a system of 5-element molecules react to form systems of interactive 6-element molecular species, and so on. A simple calculation, using data from the table, shows that during the first 750 million years of the existence of the earth the reaction rate would have been 68 million years per element. This means that for each new evolved species, e.g. such as a new 7-seven element species evolved, over the years, from a reactive system of 6-element species, it would take 68 million years per super-element species generation.

By the 3.85 BYA mark, however, according to our data table, reaction rates seemed to have slowed down. At this point, according to mass composition data sets, many 15-element species were formed and fervently existing. Subsequently, to evolve a 15-element bacteria species into a 26-element human species would require the addition or incorporation of eleven new functional elements. The rate for this reaction process calculates to be 350 million years per element. In other words, every 350 million years a new extra-element species would have formed. To compound this issue, it is known that the earth goes through periodic extinction windows every 26 million years or so.[45] The effects of these extinction cycles, can be viewed as or thought of as a way in which the earth reactor tank is stirred up, thus allowing new reactant material to be added back into the system.

From this evolution table we see that the evolution of chemical species, deriving from hydrogen and helium atom precursors, is the result of a contiguous and gradual build up of molecular structure, through chemical reaction. Moreover, this buildup invariably is mechanized into action by the influx of solar thermal energy, the form of predominately gamma-ray photons γ, into the earth system, which has resulted in the evolved development of punctuated, interlinked, electromagnetically-driven, chemical reactions, which continue onward to this very day.

The current scientific view, to review, would have us believe that somewhere, in time, between the formation of 12-element *pro-bacteria molecule* (4.0 BYA) and the formation of 15-element *prokaryote molecule* (3.85 BYA), that on a very specific magical day something happened in which a source of energy, such as geothermal activity, lightning, intense solar phenomena, meteorite showers, etc., functions to set in motion the animation of molecular movement or life as we are so accustomed. In which, after this certain day the living molecule becomes autonomous.

What bears out of this logic, is the perspective that all molecular structures are, in fact, quite alive to various degrees. Furthermore, it is reasonable to assume that all fundamental particle structures, i.e. fermions and bosons, are quite alive as well to various degrees, when viewed from the appropriate resolution and temperature. When making this distinction, however, we must always be well aware that 'life' is a technical process and exact. In the laboratory, for instance, we can always make the very same reaction repeat over and over again, resulting in the exact same thermodynamic energy calculations, bonding rearrangements, intermediates, products, etc. In sum, these distinctions can be classified as quark life, atomic life, molecular life, and galactic life, and so on, in which the 'life' in question depends on the resolution of the microscope, telescope, or macroscope used.

As to classification, all biological species are chemical species, i.e. biological structures comprised of two or more atoms in which, as a soft guide, the numbers of currently identified biological species can be broken down as follows: 287,655 plants; 10,000 lichens; 1,190,200 invertebrates, including 950,000 insects; and 57,739 vertebrates, including 28,500 fishes, 5,743 amphibians, 8,163 reptiles, 9,917 birds, and 5,416 mammals.[46] Bacterial species, by comparison, are quite abundant; a single a single gram of rich, undisturbed soil may contain as many as 5,000 different species of bacteria.[47] The number of currently identifiable sub 15-element chemical species, however, i.e. molecular structures smaller than bacteria, is over 25 million.[48]

The new theory in human chemistry, used to account for linear atomic build up nature of the molecular evolution table, is that life is a continuous process of electromagnetically driven chemical reactions, in which chemically compatible molecules react with each other, via energy requisite mate recognition systems, to form new molecular structures of like but slightly differing atomic composition. This reaction process, from a human point of view, started when the accretion disc of matter began to accumulate, interactions that began before the sun ignited. Once the sun ignited, these reactions began to accelerate. In time, human molecules were formed.

Reproductively speaking, molecules or chemical species that react together have mate recognition systems, which are dependent on the energy and stability constraints of the reaction in relation to time. The determinants of mate-specific human chemical interactions (reactions), just as with simple chemical reactions, depend on *electronic interactions*, the attraction and repulsion of nuclei with valence charges as mediated by photons, and *stereochemical requirements*, i.e. the resultant synergy arising from the dynamic shape and fit of the molecules. These same two bonding determinants, according to Australian thermoeconomist James Reiss, from his 'Comparative Thermodynamics in Chemistry and Economics', in the 1994 book *Economics and Thermodynamics*, apply for human interactions. In this manner, for human molecules or otherwise, in the early years of the earth's formation, populations of 12-element molecules, for instance, over the course of a number of

years, would be electromagnetically forced to react together, over time, owing to similar mate recognition systems, to yield new 13-element molecules, i.e. a new chemical species. This process would have continued, eventually forming system of human molecules.

What is needed here is a *unified theory of evolution*, i.e. one that unifies the main theories of sociology, biology, chemistry, physics, and thermodynamics, in such a manner that atomic structural evolution is explained in an absolute seamless manner. A unified theory must account for firstly Boyle's principles and laws of chemistry (1661), second Darwin's theory of natural selection (1859), third Gibbs' 1876 *On the Equilibrium of Heterogeneous Substances*, forth Mendel's theory of genetic inheritance (1865), fifth Planck's quantum theory (1900), sixth Burton's biological species free energy tables as found in Krebs and Kornberg's 1957 *Energy Transformations in Living Matter,* and seventh Gladyshev's thermodynamic theory of the evolution of living beings (1978).

The first person to state the basic components of such a unified principle was Danish physicist Niels Bohr who in 1913 realized correctly that it is the geometric quantum energetic relationship between the positive nucleus and negative electrons that determines system evolution. This principle states, essentially, that systems tend to reconfigure in the direction that will minimize the *internal energy* of the system. Bohr's principle is quantum mechanical and is structured on the works of the great Rudolf Clausius. The second person to state the basic components of such a unified principle was Russian physical chemist Georgi Gladyshev who in 1978 realized correctly that it is the spatial-temporal, geometric, thermodynamical relationship between the tendencies underlying the work output of molecular systems as these tendencies relate to the system stabilities that determines evolution. This principle states, essentially, that systems tend to reconfigure in the direction that will minimize the *free energy* of the system. Gladyshev's principle is thermodynamical and is structured also on the works of the great Rudolf Clausius.

Both principles are the same, only one is microscopically-based and the other is macroscopically-based. Bohr's principle was stated verbally; Gladyshev's principle, however, was stated mathematically. In short, when the earth is divided up into the correct systems-within-systems hierarchical-levels delineation, evolution within each isothermal, isobaric subsystem, per each equilibrium *relaxation window*, occurs or progresses such that the value of the Gibbs free energy per unit subsystem volume tends to a minimum.[49]

On shorter time-scales, the evolution of molecular species can be understood in terms of site specific free energy binding tendencies. Short evolutions are comprised of chemical reaction mechanisms. Basic sets of short-evolutions add up over time to form multi-year evolution-cycles. Together, evolution-cycles link up to describe the total evolution process that defines life of the earth coupled to the solar system.

Contact author

Thank you for taking the time to read *The Human Molecule*. To help in the improvement of a possible second edition, please contact the author directly at the following email, with comments, suggestions, criticism, spelling, grammatical errors, theoretical issues, typos, ideas, disagreements, or any other concerns:

Email: humanchemistry@sbcglobal.net

Owing to time restrictions, to note, the first edition published swiftly in unpolished format; hence, any helpful comments, ideas, or constructive criticism would be appreciated.

References and Notes:

"If I have seen further it is by standing
on ye shoulders of Giants."
Isaac Newton, English physicist

Back Cover

[1] Libb Thims' "thermodynamics book collection" (180+ books);
[URL]: http://www.eoht.info/page/Libb+Thims%27+thermodynamics+book+collection

Quote:

[1] Forbes, A. (1999). *Milton's Progress* (ch. 21). A Digital Novel. Beaverton, Ontario: Rowanlea Grove Press. [URL]: http://www.rowanlea.com/rgp/index.html

Preface:

[1] Taine, Hippolyte. (1870). *De l'Intelligence* (On Intelligence), (Volumes I & II), (pg. xi-xii), (Preface dated Dec., 1869). London: L. Reeve and Co.
[2] (a) Thims, Libb. (2007). *Human Chemistry (Volume One).* USA: LuLu.
(b) Thims, Libb. (2007). *Human Chemistry (Volume Two).* USA: LuLu.
(c) Sterner, Robert W. and Elser, James J. (2002). *Ecological Stoichiometry: the Biology of Elements from Molecules to the Biosphere*, (pgs. 3, 47, 135). Princeton: Princeton University Press.

1 – What is a Human: Early Views?

[1] World POPClock Projection. U.S. Census Bureau, Population Division/International Programs Center.
[URL]: http://www.census.gov/ipc/www/popclockworld.html
[2] Wells, Spencer. (2002). *The Journey of Man – A Genetic Odyssey,* (pgs. 32-33). New York: Random House.
[3] (a) Human Molecule (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Human+molecule
(b) The first calculation for the approximate molecular formula for the average person was completed, independently, in April 2000 by American limnologists Robert Sterner and James Elser, and independently in September 2002 by American chemical engineer Libb Thims.
(c) See: the "Calculations Section" of the Molecular Evolution Table (for derivation);
[URL]: http://www.humanthermodynamics.com/Evolution-Table.html
(d) Thims, Libb. (2007). *Human Chemistry (Volume One),* (ch. 2: "The Human Molecule", pgs: 15-35). USA: LuLu publishers.
(e) Sterner, Robert W. and Elser, James J. (2002). *Ecological Stoichiometry: the Biology of Elements from Molecules to the Biosphere*, (pgs. 3, 47, 135). Princeton: Princeton University Press.
[4] (a) Cotterell, Arthur. (1999). *Encyclopedia of World Mythology,* (pg. 13). New York: Barnes & Nobel Books.
(b) Jordan, Michael. (1993). *Encyclopedia of Gods – Over 2,500 Deities of the World.* New York: Facts on File, Inc.

[5] Encyclopedia Britannica (online), 2007
[6] Ball, Philip. (2004). *Critical Mass – How one Thing Leads to Another,* (pg. 17). New York: Farrar, Straus and Giroux.
[7] Molecule (from Fr. *moléclue* (1678), from Mod.L. *molecula,* dim. of L. *moles* "mass, barrier"); *Online Etymology Dictionary* [URL]: http://www.etymonline.com/
[8] Newton, Isaac. (1704). *Opticks* (Query 31: On the small particles of bodies); London: Printers to Royal Society. Note: several editions published between 1704 and 1730.
[9] Kim, Mi Gyung. (2003). *Affinity, That Elusive Dream – A Genealogy of the Chemical Revolution*. Cambridge, Mass: The MIT Press.
[10] (a) Crosland, M.P. (1959). "The use of diagrams as chemical equations in the lecture notes of William Cullen and Joseph Black." *Annals of Science,* Vol. 15, No. 2, June.
(b) Thims, Libb. (2007). *Human Chemistry (Volume Two),* (ch. 10: Goethe's Affinities). Morrisville, NC: LuLu.
[11] (a) Cox, Catharine, M. (1926). *Early Mental Traits of Three Hundred Geniuses (Genetic Studies of Genius Series)*, Stanford Univ Press.
(b) Thims, Libb. (2007). *Human Chemistry (Volume Two),* (ch. 10: Goethe's Affinities). Morrisville, NC: LuLu.
[12] Free will (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Free+will
[13] Levere, Trevor, H. (1971). *Affinity and Matter – Elements of Chemical Philosophy 1800-1865*. Great Britain: Oxford University Press.
[14] (a) Taine, Hippolyte. (1870). *De l'Intelligence* (On Intelligence), (Volumes I & II), (pg. xi-xii), (Preface dated Dec., 1869). London: L. Reeve and Co.
(b) Hippolyte Taine (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Hippolyte+Taine
[15] Huxley, Thomas. (1871). "Administrative Nihilism", *Fortnightly Review,* pg. 536. Nov. 1.
[16] Social chemistry (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Social+chemistry
[17] Stark, Werner. (1962). *The Fundamental Forms of Social Thought.* (pgs. 261-63). Routledge.
[18] Ball, Philip. (2004). *Critical Mass - How One Thing Leads to Another,* (pgs. 65-69, 205). New York: Farrar, Straus and Giroux.
[19] Comments by S.R. de Groot in the forward to Boltzmann's *Theoretical Physics and Philosophical Problems*.
[20] Boltzmann, Ludwig. (1872). "Weitere Studien über das Wärmegleichgewicht unter Gasmolekülen." ('Further Studies on the Thermal Equilibrium of Gas Molecules'.) In *Wisssenschaftliche Abhandlungen, ed.* F. Hasenohrl, vol.1, pg. 317. J.A. Barth, Leipzig, 1909.
[21] Quoted in L. Campbell & W. Garnett (1882). *The Life of James Clerk Maxwell,* pgs. 294-95, 438-39. London: Macmillan.
[22] Maxwell, James Clerk, "Molecules". *Nature*, September, 1873;
[URL]: http://www.thecore.nus.edu.sg/landow/victorian/science/science_texts/molecules.html
[23] (a) Prugh, Thomas, Costanza, Robert, Daly, Herman, Goodland, Robert, Cumberland, John H., and Norgaard, Richard B. (1999). *Natural Capital and Human Economic Survival,* 2nd ed. (pg. 15). CRC.
(b) Prugh, Thomas, Costanza, Robert, and Daly, Herman E. (2000). *The Local Politics of Global Sustainability,* (pg. 79). Island Press.
[24] Ingrao, B. and Israel, G. (1990). *The Invisible Hand,* (pgs. 87-88). Cambridge, MA: MIT Press.
[25] Beinhocker, Eric D. (2006). *The Origin of Wealth – Evolution, Complexity, and the Radical Remaking of Economics,* (pgs. 29-33). Boston: Harvard Business School Press.

[26] Leon Walrus (*Encyclopedia Britannica*, 1911 ed.);
[URL]: http://www.1911encyclopedia.org/Marie_Esprit_Leon_Walras
[27] (a) Edgeworth, Francis Y. (1881). *Mathematical Physics: an Essay on the Application of Mathematics to the Moral Sciences* (pgs. 12-13, 50). London: Kegan Paul & Co.
(b) Ball, Philip. (2004). *Critical Mass - How One Thing Leads to Another,* (205). New York: Farrar, Straus and Giroux.
[28] Schiller, Ferdinand C.S. (1894). *Riddles of the Sphinx: a Study in the Philosophy of Evolution* (section: "Love and the Social Ideal", pgs. 422-28), 2nd ed. MacMillan.
[29] Boutmy, Emile G. (1904). *The English People: A Study of Their Political Psychology.* (ch. 5: "Royalty", pg. 186). Great Britain: T. F. Unwin.
[30] Strathern, Paul. (2000). *Mendeleyev's Dream – the Quest for the Elements.* New York: Berkley Book.
[31] Fairburn, William A. (1914). *Human Chemistry*. (55pgs). New York: The Nation Press.
[32] Clark, John, O.E. (2004). *The Essential Dictionary of Science.* New York: Barnes & Noble.
[33] (a) Entropy (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Entropy
(b) Thims, Libb. (2007). *Human Chemistry (Volume One),* (entropy components of the human chemical bond, pgs. 270-72). Morrisville, NC: LuLu.
[34] Campbell, Arthur, J. (1965). *Why do Chemical Reactions Occur?* Englewood Cliffs, J. N.: Prentice-Hall, Inc.
[35] Chemical affinity (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Chemical_affinity
Elective Affinities (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Elective_Affinities

2 – Pareto's 1896 Human Molecules:

[1] Pareto, Vilfredo. (1896-97). *Cours d'Economie Politique*. Vol. 2, pg. 397.
[2] McLure, Michael. (2001). *Pareto, Economics and Society: The Mechanical Analogy*, (pg. 43). Routledge.
[3] Young, Robert M. (1971)."Mystifications in the Scientific Foundations of Sociology", Science *or Society?: Bulletin of the Cambridge Society for Social Responsibility in Science* No. 2, June 1971, pp. 9-11. [URL]: http://human-nature.com/rmyoung/papers/paper88.html
[4] Homans, George C. & Curtis, Charles P. (1934). *An Introduction to Pareto: His Sociology.* New York: Knopf.
[5] Cunningham, John and McLure, Michael. (1999). *Vilfredo Pareto: Critical Assessments of Leading Economist,* (pg. 442). Routledge.
[6] Vine, Margaret Wilson. (1969). *An Introduction to Sociological Theory*, (pg. 256). D McKay Co.
[7] Berdayes, Vicente and Murphy, John W. (2000). *Computers, Human Interaction, and Organizations: Critical Issues,* (pg. 235). Greenwood Publishing Co.
[8] Pareto, Vilfredo. (1966). *Sociological Writings*, (pgs. 130-31). Pall Mall Press.
[9] Ibid, pg. 252.
[10] Timasheff, Nicholas. (1967). *Sociological Theory: Its Nature and Growth*, (p. 162) New York: Random House.
[11] Vilfredo Pareto (1848-1923); [URL]: http://cepa.newschool.edu/het/profiles/pareto.htm
[12] Reiser, Oliver. L. (1935). *Philosophy and the Concepts of Modern Science,* (pg. 225). The MacMillan Company.
[13] Cannon, Walter B. (1943). "Biographical Memoir of Lawrence Joseph Henderson 1878-1942", *US National Academy of Science,* Vol XXIII, Second Memoir.
[PDF]: http://books.nap.edu/html/biomems/lhenderson.pdf

3 – Adams' 1910 Human Molecules:

[1] (a) Adams, Henry. (1910). *A Letter to American Teachers of History*. Washington. Google books: [URL]: http://books.google.com/books?id=gaLdOOzuiKAC
(b) Henry Adams (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Henry+Brooks+Adams
[2] (a) Thims, Libb. (2007). *Human Chemistry (Volume Two),* (ch. 13: "Human Chemical Bonding", pgs. 515-560). Morrisville, NC: LuLu.
(b) Human chemical bond (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Human+chemical+bond
[3] Leff, Harvey. (2002). *Maxwell's Demon 2: Entropy, Classical and Quantum Information, Computing,* (pg. 45). New York: Taylor & Francis.
[4] Perrin, Jean, B. (1926). "Discontinuous Structure of Matter", *Nobel Lecture*, December 11, [URL]: http://nobelprize.org/cgi-bin/print?from=/nobel_prizes/physics/laureates/1926/perrin-lecture.html

4 – Teilhard's 1936 Human Molecules:

[1] Teilhard, Pierre de Chardin. (1955). *The Phenomenon of Man* (written in the 1930s).
[2] Teilhard, Pierre de Chardin. *The Future of Man,* (pg. 59). Image Books.
[3] Teilhard, Pierre de Chardin. (2002). *Activation of Energy: Enlightening Reflections on Spiritual Energy,* (pg. 24, 27, 49, 295-96). Harvest Books.
[4] Molecular Evolution Table: "Calculation Section" (Institute of Human Thermodynamics);
[URL]: http://www.humanthermodynamics.com/Evolution-Table.html
[5] Molecular Evolution Table (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Molecular+evolution+table
[6] Teilhard, Pierre de Chardin. (1941). "The Atomism of Spirit" (found in *Activation of Energy*, pgs. 23-57, New York: Harvest Books, 1978).
[7] Teilhard, Pierre de Chardin. (1947). "The Formation of the Noosphere". (pg. 170-74); from the book *The Future of Man*, New York: Harper and Row, 1969.
[URL]: http://www.supremelaw.org/authors/teilhard/noospher.htm
[8] (a) Thims, Libb. (2007). *Human Chemistry (Volume Two),* (ch. 13: "Human Chemical Bonding", pgs. 515-560). Morrisville, NC: LuLu.
(b) Human chemical bond (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Human+chemical+bond
[9] Teilhard, Pierre de Chardin. (1953). "The Energy of Evolution" (found in *Activation of Energy*, pgs. 361-72, New York: Harvest Books, 1978).

5 – Darwin's 1952 Human Molecules:

[1] Charles Robert Darwin (Quote): Letter to Emma Darwin, 5 July 1884. In F. Burkhardt and S. Smith (eds.), *The Correspondence of Charles Darwin 1844-1846* (1987), Vol. 3, 43.
[2] Darwin, Charles, G. (1952). *The Next Million Years*. pg. 26, London: Rupert Hart-Davis.
[3] (a) Note: Darwin actually only used the term 'statistical mechanics'; both subjects, however, very similar and were founded by the same authors: Rudolf Clausius (1850s), James Maxwell (1859), Ludwig Boltzmann (1870), and Willard Gibbs (1901).
(b) Statistical thermodynamics (Wikipedia);
[URL]: http://en.wikipedia.org/wiki/Statistical_thermodynamics
(c) Statistical mechanics (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Statistical_mechanics
[4] Free will (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Free+will

6 – Intermediate Views:

[1] (a) Mumford, L. (1946). *The Culture of Cities,* (pg. 93). London: Secker & Warburg.
(b) Ball, Philip. (2004). *Critical Mass – How One Thing Leads to Another,* (pg. 23). New York: Farrar, Straus and Giroux.
[2] (a) Heilbroner, Robert. (1999). *The Worldly Philosophers: the Lives, Times, and Ideas of the Great Economic Thinkers,* (pgs. 176, 316-17). London: Penguin.
(b) Note: the 1st edition was written in 1953 and has sold more than four million copies through seven editions. The only other book on the same subject to sell more copies is Paul Samuelson's 1948 *Economics*.
[3] Zeig, Jeffrey, K. (1987). *The Evolution of Psychotherapy* (Section: "Psychodrama, Role Theory, and the Concept of the Social Atom" by Zerka T. Moreno (wife of Jacob), pgs. 341-366). Psychological Press.
[4] (a) Moreno, J. L. (1951). *Sociometry, Experimental Method and the Science of Society: An Approach to a New Political Orientation.* Beacon, NY: Beacon House.
(b) Moreno, J. L. (1953). *Who Shall Survive? Foundations of Sociometry, Group Psychotherapy and Sociodrama* (student ed.). Roanoke, VA: Royal.
(c) Remer, Rory. (2001). "Social Atom Theory revisited", *International Journal of Action Methods: Psychodrama, Skill Training, and Role Playing,* June 22.
[5] Remer, Rory. (2006). "Chaos Theory Links to Morenean Theory: A Synergistic Relationship", 30 pgs. (Section: Social Atom Theory). Heldref Publications.
[PDF]: http://www.heldref.org/remersum06.pdf
[6] Remer, Rory. (2001). "Social Atom Theory revisited", *International Journal of Action Methods: Psychodrama, Skill Training, and Role Playing,* June 22.
[URL]: http://www.highbeam.com/doc/1G1-95765054.html
[7] (a) Prigogine, I. (1984). *Order Out of Chaos*, (pgs. xv, 13, 142, 300, 312-13). New York: Bantam Books.
(b) Kondepudi, D. & Prigogine, I. (1998). *Modern Thermodynamics – From Heat Engines to Dissipative Structures*. New York: John Wiley & Sons.
[8] Schneider, E.D. & Sagan, E. (2005). *Into the Cool – Energy Flow, Thermodynamics, and Life*. Chicago: University of Chicago Press.
[9] Thims, L. (2005). *125+ Variations of the 2nd Law of Thermodynamics*, Chicago: IoHT Publications. [URL]: http://www.humanthermodynamics.com/2nd-Law-Variations.html
[10] Mendoza, E. (1960). "Introductory Section Notes" (pg. viii) to the Dover Reprint of: Carnot, S. (1988). *Reflections on the Motive Power of Fire and other Papers on the Second Law of Thermodynamics by E. Clapeyron and R. Clausius*. New York: Dover Publications, Inc.
[11] Thomson, W., [Lord Kevin], (1852). "On a Universal Tendency in Nature to the Dissipation of Mechanical Energy." Proceedings of the Royal Society of Edinburgh, April 19.
[URL]: http://zapatopi.net/kelvin/papers/on_a_universal_tendency.html
[12] Maxwell, J.C. (1876). *Matter and Motion*. New York: Dover Publications, Inc.
[13] *Oxford Dictionary of Science*, 5th Ed. (2005). New York: Oxford University Press.
[14] Gladyshev, G.P. (1978). "On the Thermodynamics of Biological Evolution." *Journal of Theoretical Biology, Vol. 75, Issue 4, Pgs. 425-41.*
[URL]: http://www.sciencedirect.com/science/journal/00225193
[15] Climax ecosystem (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Climax_ecosystem
[16] Poitevin, B. (1995). "Mechanism of Action of Homeopathic Medicines." *British Homeopathic Journal.*, v. 84, No. 2, pgs. 102-107.
[17] Thims, Libb. (2007). *Human Chemistry (Volume One),* (ch. 9: "Human Molecular Orbitals", pgs. 247-295). Morrisville, NC: LuLu.
[18] (a) Dragulescu, A. and Yakovenko, V.M. (2000). "Statistical Mechanics of Money", *The European Physical Journal B,* 17, 723-29.

(b) Chatterjee, Arnab, Chakrabarti, Bikas K., and Manna, S.S. (2003). "Money in Gas-Like Markets: Gibbs and Pareto Laws", *Physica Scripta* T106, 36-38.
(c) Gonzalez-Estevez, J. Cosenza, M.G., Lopez-Ruiz, R. and Sanchez, J.R. (2008). "Pareto and Boltzmann-Gibbs Behaviors in a Deterministic Multi-agent System", *Elsevier,* Jan 07.
[19] (a) Human particle (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Human+particle
(b) Surface chemistry (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Surface+chemistry
[20] To elaborate on this issue further would consume to many pages.

7 – Advanced Intelligence Perspective:

[1] (a) Merriam-Webster Collegiate Dictionary, 2000, CD-ROM
(b) Human (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Human
[2] Ball, P. (2004). *Critical Mass – How One Thing Leads To Another*. New York: Farrar, Straus and Giroux.
[3] (a) Bar-Yam, Y. (1997). *Dynamics of Complex Systems*. Reading, Massachusetts: Addison-Wesley.
(b) Complex systems (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Complex_system
[4] (a) Eldredge, N. (2004). *Why We Do It – Rethinking Sex and the Selfish Gene.* [pgs. 64-67]. New York: W.W. Norton & Company.
(b) Gould, J.L. & Gould, C.G. (1997). *Sexual Selection – Mate Choice and Courtship in Nature.* New York: Scientific American Library. [pgs. 103-106]
(c) Lovelock, J. (2000). *Gaia – A New Look at Life on Earth.* Oxford: Oxford University Press. [pg. 84].
[5] Change, R. (1998). *Chemistry 6th Ed*. New York: McGraw-Hill
[6] (a) Gribbin, J. (2000). *Q is for Quantum - an Encyclopedia of Particle Physics*. New York: Simon & Schuster.
(b) Interaction (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Interaction
[7] *Oxford Dictionary of Science*, 5th Ed. (2005). New York: Oxford University Press.
[8] Fundamental interactions (Wikipedia);
[URL]: http://en.wikipedia.org/wiki/Fundamental_interaction
[9] Nowak, M.A. (2006). *Evolutionary Dynamics: the Equations of Life.* New York: Belknap Press.
[10] Reiser, Oliver. L. (1935). *Philosophy and the Concepts of Modern Science,* (pg. 225). The MacMillan Company.
[11] Rosnay, Joel de. (1975). *The Macroscope – A New World Scientific System.* New York: Harper & Row Publishers. (pg. xiv).
[12] Infante, Alfredo, P. & Lawler, James, H.L. (2001). *"Social Entropy".* Source: The Nexial Institute. [URL]: http://www.nexialinstitute.com/social_entropy.htm
[13] McNeill, J.R. & McNeill, W.H. (2003). *The Human Web – A Birds-Eye View of World History.* (pg. 3) New York: W.W. Norton & Company.

8 – Modern Views:

[1] (a) Human chemistry (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Human+chemistry
(b) Human thermodynamics (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Human+thermodynamics
(c) Social physics (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Social+physics

[2] (a) Heymsfield, S. B., Waki, M. Kehayias, J., Lichtman, S., Dilmanian, F. A., Kamen, Y., Wang, J., and Pierson, Jr. R.N. (1991). "Chemical and Elemental Analysis of Humans *in vivo* Using Improved Body Composition Models", *Am. J. Physiol.* 261: E190-E198.
(b) Williams, R.J.P. and Frausto da Silva, J.J. R. (1996). *The Natural Selection of the Chemical Elements: The Environment and Life's Chemistry.* Oxford: Clarendon.
(c) Emsley, John. (2001). *Nature's Building Blocks: An A-Z Guide to the Elements.* Oxford: Oxford University Press.
[3] Daintith, John. (2004). *Oxford Dictionary of Chemistry.* New York: Oxford University Press.
[4] (a) Harrison, G. (1965). *The Role of Science in Our Modern World,* (quote: "the body contains 2 percent of the atoms that were spinning in it one year ago", pg. 95). New York: William Morrow,.
(b) Margulis, L. & Sagan, C. (1995). *What is Life?,* (quote: "every year, 98 percent of the atoms in your body are replaced", pg. 17). Berkeley: University of California Press.
(c) Sterner, Robert W. and Elser, James J. (2002). *Ecological Stoichiometry – the Biology of the Elements from Molecules to the Biosphere,* (pg. 3, 47, 135). Princeton: Princeton University Press.
[5] (a) Thims, Libb. (2007). *Human Chemistry (Volume One)*. Morrisville, NC: LuLu.
(b) Thims, Libb. (2007). *Human Chemistry (Volume Two)*. Morrisville, NC: LuLu.
[6] Erich Müller (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Erich+M%C3%BCller
[7] Van der Waals force (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Van_der_Waals_force
[8] Statistical thermodynamics (Wikipedia);
[URL]: http://en.wikipedia.org/wiki/Statistical_thermodynamics
[9] Factoid: in 1885, Henry E. Armstrong offered the world's first course in "chemical engineering" at Central College (later Imperial College London).
[URL]: http://en.wikipedia.org/wiki/Chemical_engineering#ChE_timeline
[10] Publications of Erich Müller (1983-2006), Imperial College London: Facility of Engineer: Department of Chemical Engineering and Chemical Technology;
[URL]: http://www3.imperial.ac.uk/people/e.muller/publications
[11] Müller, E.A. (2002). *Termodinamica basica*, Caracas, Kemiteknik.
[12] Müller, Erich. A. (1998). "Human Societies: a Curious Application of Thermodynamics." *Chemical Engineering Education,* Vol. 1, No. 3, Summer.
[URL]: http://cee.che.ufl.edu/Journals/summer1998/Müller.htm
[13] Thims, L. (2006). "High School Cafeteria Seating Distributions" Chicago: IoHT Publications. [URL]: http://www.humanthermodynamics.com/RP/Cafeteria-Densities.html
[14] Combined law of thermodynamics (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Combined+law+of+thermodynamics
[15] (a) Müller stability ratios (definition): the ratio of attraction-to-repulsion in a social aggregate (by analogy to Gottman stability ratios, in which stable long-term marriages have a 5-to-1 ratio of attraction to repulsion in the exchange force of their bond).
(b) Müller stability ratio (EoHT): http://www.eoht.info/page/M%C3%BCller+stability+ratio
(c) Gottman stability ratio (EoHT): http://www.eoht.info/page/Gottman%20stability%20ratio
(d) Thims, Libb. (2007). *Human Chemistry (Volume One),* (Section: "Gottman stability ratios", pgs. 179-182). USA: LuLu.
(e) Gottman, John. (1994). *Why Marriages Succeed or Fail.* New York: Fireside.
(f) Thims, Libb. (2007). *Human Chemistry (Volume Two),* (Section: "Müller dispersion forces", pgs. 629-38). USA: LuLu.
[16] Gallagher, Laura. (2006). "A Thermodynamic Personality: Interview with Erich Müller", *Reporter,* Issue 162, 24 February. [URL]:
www3.imperial.ac.uk/reporter/previousissues/issue162_24february2006/athermodynamicpersonality

[17] (a) Source for Sterner date: "I have attached the spreadsheet used to construct that formula for a human molecule in our book. My copy of the spreadsheet is dated April 18, 2000. I cannot say exactly when we made the calculations. That date might have to do with some modification of the figure or some other edit. At any rate, it gives an indication." (email communicate from Robert Sterner to Libb Thims on February 20, 2008).
(b) Note: Thims only became aware of Sterner's calculation on February 17, 2008 after doing a Google book search on keywords "human molecule thermodynamics"; Thims then emailed Sterner within the hour.
[18] Sterner and Elser's 2002 *Ecological Stoichiometry,* pg. xviii
[19] Sterner and Elser's 2002 *Ecological Stoichiometry,* pg. 7
[20] Libb Thims (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Libb+Thims
[21] (a) Thims, Libb. (2002). *Human Thermodynamics (Volume One).* Chicago: Institute of Human Thermodynamics
(b) Thims, Libb. (2003). *Human Thermodynamics (Volume Two).* Chicago: Institute of Human Thermodynamics
(c) Thims, Libb. (2004). *Human Thermodynamics (Volume Three).* Chicago: Institute of Human Thermodynamics
(d) Thims, Libb. (2005). Cessation *Thermodynamics.* Chicago: Institute of Human Thermodynamics
(e) IoHT Bookstore [URL]: http://www.humanthermodynamics.com/HT-books.html
[22] (a) Human Molecule (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Human+molecule
(b) See: the "Calculations Section" of the Molecular Evolution Table (for derivation);
[URL]: http://www.humanthermodynamics.com/Evolution-Table.html
(c) Thims, Libb. (2007). *Human Chemistry (Volume One),* (ch. 2: "The Human Molecule", pgs: 15-35). USA: LuLu publishers.
[23] (a) Note1: E27 = 10^{27}, etc. Note2: the formula and concept of a 'human molecule' was derived, independently, by Thims in 2002, in a treatise on *Cessation Thermodynamics*.
(b) Thims, L. (2005). *Institute of Human Thermodynamics*: Molecular Evolution Table - calculations & discussions. Full derivation for the human molecular formula:
[URL]: http://www.humanthermodynamics.com/Evolution-Table.html
(c) Formulaic Methodology: http://www.humanthermodynamics.com/symbols.html
(d) Mass Composition Table: http://www.humanthermodynamics.com/mass-composition-table.html
(e) Periodic Table Arrangement: http://www.humanthermodynamics.com/periodic-table.html
[24] Uthman, Ed. (2000). "Elemental Composition of the Human Body",
[URL]: http://web2.iadfw.net/uthman/elements_of_body.html
[25] Thims, Libb. (2005). Molecular Evolution Table (calculation section); Chicago: IoHT.
[URL]: http://www.humanthermodynamics.com/Evolution-Table.html
[26] (a) Georgi Gladyshev (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Georgi+Pavlovich+Gladyshev
(b) Gladyshev G. P. (2006). "The Principle of Substance Stability is Applicable to all Levels of Organization of Living Matter", (pg. 10). *Int. J. Mol. Sci., 7, 98-110 - International Journal of Molecular Sciences*; [PDF]: http://www.mdpi.org/ijms/papers/i7030098.pdf
(c) Gladyshev G. P. (2006). Leonhard Euler's methods and ideas live in the thermodynamic hierarchical theory of biological evolution. International Journal of Applied Mathematics and Statistics (IJAMAS) Centre for Environment and Economic Research (CESER), Roorkee - 247667, India.. 2006 Vol. , Nu. pp. [*human molecule* concepts discussed.]
[URL]: http://www.geocities.com/ceser_info/ijams.html

(d) Georgi P. Gladyshev. (2006). *The invited and guest speakers. The lecture: The thermodynamic theory of aging in action: medical nutrition recommendations for patients of any age.* The 14th Annual International Conference on Anti-Aging Medicine, held at Stephens Convention Center, Rosemont, IL, July 14-16, 2006. American Academy of Anti-Aging Medicine (A4M). [*human molecule* concepts presented in lecture.]
(e) Georgi P. Gladyshev (2005). "The Second Law of Thermodynamics and the Evolution of Living Systems", Journal of Human Thermodynamics (JHT), Vol. 1, Issue 7 [pg. 68-81] - December (ISSN: 1559-386X) [*human molecule* concepts discussed.]
[URL] http://www.humanthermodynamics.com/JHT/Second-Law-Systems-Evolution.html
[27] Gladyshev G. P. (2006). "The Principle of Substance Stability is Applicable to all Levels of Organization of Living Matter", (pg. 10). *Int. J. Mol. Sci., 7, 98-110 - International Journal of Molecular Sciences*; [PDF]: http://www.mdpi.org/ijms/papers/i7030098.pdf
[28] (a) Daintith, J. (2004). *Oxford Dictionary of Chemistry 5th Ed.* Oxford: Oxford University Press. By supramolecular extrapolation (b) → (c):
(b) Molecule (definition): *One of the fundamental units forming a chemical compound; the smallest part of a chemical compound that can take part in a chemical reaction* (Oxford).
(c) Human molecule (definition): the "human molecule" is the fundamental unit of the chemical social collective (compound); being the smallest part of the chemical compound that can take part in a (human) chemical reaction.
(d) Compound (definition): *A substance formed by the combination of elements in fixed proportions. The formation of a compound involves a chemical reaction; i.e. there is a change in the configuration of the valance electrons of the atoms.* (Oxford).
[29] Cessation thermodynamics (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Cessation+thermodynamics
[30] Reaction spontaneity (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Spontaneity
[31] Cahan, David. (1993). *Hermann von Helmholtz and the Foundations of Nineteenth-Century Science.* Berkeley: University of California Press.
[32] Molecule (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Molecule
Biomolecule (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Biomolecule
Macromolecule (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Macromolecule
Supermolecule (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Supermolecule
[34] Thims, L. (2005). "Earth Molecule" – Calculations, Derivations, and Related:
[URL]: http://www.humanthermodynamics.com/Glossary/E.html
[35] Note: the number of "naturally occurring" elements on earth ranges, per source, from 90-94; 92, however, is the most prominent figure.
[36] Earth Molecule (calculations);
[URL]: http://www.humanthermodynamics.com/earth-calculations.html
[37] Yarris, L. (1999). "New Superheavy Elements 116 and 118 Discovered at Berkeley Lab"
[URL]: http://enews.lbl.gov/Science-Articles/Archive/elements-116-118.html
[38] Thims, L. (2006). "Sun Molecule" – Calculations, Derivations, and Related:
[URL]: http://www.humanthermodynamics.com/Glossary/S.html#anchor_567
[39] Composition of the Sun (Georgia State University); Hyperphysics:
[URL]: http://hyperphysics.phy-astr.gsu.edu/hbase/tables/suncomp.html
[39] (a) Dozens of scientists have speculated in this direction, including: Newton, Faraday, Maxwell, and Gamow.
(b) Chemical gravitation, to note, should account, essentially, for Archimedes's principle (c.250BC), Kepler's three laws of motion (1609), Newton's three laws of motion (1687), Newton's law of universal gravitation (1687), Maxwell's field equations (1864), Gibbs' chemical thermodynamics (1876), Einstein's general relativity (1916), quantum field theory

(1927), the molecular formulas for humans, the earth, and the sun, etc., as well as the effects of particle spin and movement, and a few other details.
[40] Free will (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Free+will
[41] (a) Thims, Libb. (2007). *Human Chemistry (Volume One)*. Morrisville, NC: LuLu.
(b) Thims, Libb. (2007). *Human Chemistry (Volume Two)*. Morrisville, NC: LuLu.
[42] (a) Taghavi, Sehed M. (2004). *The Flourishing of Islamic Reformism in Iran: Political Islamic Groups in Iran (1941-61),* (pg. 96). Routledge.
(b) Bazargan, *Eshq va Parastesh ya Thermodynamic-e Ensan*, 87.
(c) Mehdi Bazargan (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/Mehdi+Bazargan
(d) Human-thermodynamicist (EoHT): http://www.eoht.info/page/Human+thermodynamicist
[43] Stokes, Philip. (2002). *Philosophy 100 - Essential Thinkers*, (pgs. 78-79).New York: Enchanted Lion Books.
[44] Nobel Prize in Medicine (1967);
[URL]: http://nobelprize.org/nobel_prizes/medicine/laureates/1967/
[45] (a) 1956 (comic-style) molecule man precursor.
[URL]: http://www.marvunapp.com/Appendix2/moleculemants.htm
(b) Molecule Man (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Molecule_Man
[46] Prugh, Thomas, Costanza, Robert, Daly, Herman, Goodland, Robert, Cumberland, John H., and Norgaard, Richard B. (1999). *Natural Capital and Human Economic Survival,* 2nd ed. (pg. 17). CRC.
[47] David Hwang (Encyclopedia of Human Thermodynamics);
[URL]: http://www.eoht.info/page/David+Y.+Hwang
[48] Hwang, David. (2001). "The Thermodynamics of Love", *Journal of Hybrid Vigor*, Issue 1, Emory University; [URL]: http://www.students.emory.edu/HYBRIDVIGOR/issue1/thermo.htm
[49] Fuller, S. (2005). "I am not a molecule". New Scientist Print Edition, June. Issue 2502.
[URL]: http://www.newscientist.com/channel/opinion/mg18625024.800
[50] Kwon, K.; Wong, K.; Pawin, G.; Bartels, L.; Stolbov, S.; Rahman, T., *Unidirectional Adsorbate Motion on a High-Symmetry Surface: 'Walking' Molecules can Stay the Course*. Phys. Rev. Lett**.** (2005), in press (Oct).
[51] University of California Riverside Newsroom (2005). "Molecule Walks Like Human". (article); [URL]: http://www.newsroom.ucr.edu/cgi-bin/display.cgi?id=1166
[52] Staff writer (2007). "Walking Molecule Now Carries Packages", *PhysOrg,* Jan. 18.
[URL]: http://www.physorg.com/news88353151.html
[53] Eadon, J. (2001-08). Discussion + Poll: "Are you a Giant Molecule?"; Poll of 310 people, results: 57% of people, when polled, agree that they are, in fact, a molecule.
[URL]: http://www.eadon.com/phil/humanchemical.php
[54] (a) Daintith, J. (2004). *Oxford Dictionary of Chemistry 5th Ed.* Oxford: Oxford University Press. By supramolecular extrapolation (b) → (c):
(b) Chemistry (definition): *The study of the elements and the compounds they form. Chemistry is mainly concerned with the effects that depend on the outer electrons in atoms.* (Oxford).
(c) Human Chemistry (definition): *The study of human molecules (built from elements) and the social structures* (analogs to compounds) *they form. Human chemistry is mainly concerned with the effects that depend on the outer electrons in the atoms of human molecules.*
[55] (a) Change, R. (1998). *Chemistry 6th Ed*. New York: McGraw-Hill
(b) Clark, J. (2004). *The Essential Dictionary of Science,* New York: Barnes & Noble.
[56] Starr, C. Taggart, R. (1992). *Biology – the Unity and Diversity of Life, 6th Ed*. (textbook). Belmont California: Wadsworth publishing Company.

[57] Hwang, David. (2002). "The Thermodynamics of Love." Emory University: *Hybrid Vigor* (Journal) – the Science of Love.
[URL]: http://www.students.emory.edu/HYBRIDVIGOR/issue1/thermo.htm
[58] IoHT Symbol Choice Methodologies. [URL]:
http://www.humanthermodynamics.com/symbols.html
[59] Note: in human chemistry, we will adhere to the symbol choices of *Mx* = male molecule, 'x' in relation to extreme-sports, *Fy* = female molecule, 'y' in relation to gynecology, and *Bc* = baby, infant, or child molecule. This, in conclusion, is owing to the fact that it seems to intuitively feel strange or unnatural to use the symbol choices of: '*My*' for the male molecule and '*Fx*' for female molecule, as would be the case if we let the twenty-third chromosome rule dictate.
[60] (a) IoHT Symbol Choice Methodologies.
[URL]: http://www.humanthermodynamics.com/symbols.html
(b) Thims, L. (2005). *Cessation Thermodynamics*. Chicago: IoHT Publications.
[61] (a) Bearman PS, Moody J, Stovel K. (1995). *American Journal of Sociology, Vol. 100, No. 1.* "Chains of affection: The structure of adolescent romantic and sexual networks."
(b) Nodal map of attachments [URL]: http://researchnews.osu.edu/archive/chainspix.htm
(c) Peter S. Bearman, James Moody, and Katherine Stovel. (2004). "Chains of affection: The structure of adolescent romantic and sexual networks", *American Journal of Sociology* 110, 44-91 (2004). [PDF]: http://www.soc.duke.edu/~jmoody77/chains.pdf
[62] Romantic relationships were ones in which the students named the other as a romantic partner. Non-romantic sexual partners were those in which the participants said they had sexual intercourse, but were not dating.
[63] Merriam-Webster Collegiate Dictionary, 2000, CD-ROM, version 2.5.
[64] (a) Georgi P. Gladyshev (2006). The Principle of Substance Stability is Applicable to all Levels of Organization of Living Matter, *Int. J. Mol. Sci.*, *7*, 98-110 - *International Journal of Molecular Sciences* (IJMS) (ISSN: 1422-0067 Online; ISSN: 1424-6783). [*human molecule* concepts discussed.] [PDF]: http://www.mdpi.org/ijms/papers/i7030098.pdf;
[URL]: http://www.mdpi.org/ijms/list06.htm
(b) Gladyshev G. P. (2006). Leonhard Euler's methods and ideas live in the thermodynamic hierarchical theory of biological evolution. International Journal of Applied Mathematics and Statistics (IJAMAS) Centre for Environment and Economic Research (CESER), Roorkee - 247667, India.. 2006 Vol. , Nu. pp. [*human molecule* concepts discussed.];
[URL]: http://www.geocities.com/ceser_info/ijams.html
(c) Georgi P. Gladyshev. (2006). *The invited and guest speakers. The lecture: The thermodynamic theory of aging in action: medical nutrition recommendations for patients of any age.* The 14th Annual International Conference on Anti-Aging Medicine, held at Stephens Convention Center, Rosemont, IL, July 14-16, 2006. American Academy of Anti-Aging Medicine (A4M). [*human molecule* concepts presented in lecture.]
(d) Georgi P. Gladyshev (2005). "The Second Law of Thermodynamics and the Evolution of Living Systems", Journal of Human Thermodynamics (JHT), Vol. 1, Issue 7 [pgs. 68-81] - Dec (ISSN: 1559-386X) [*human molecule* concepts discussed.]
[URL] http://www.humanthermodynamics.com/JHT/Second-Law-Systems-Evolution.html
(e) Liss, L. (2005). "Human Thermodynamics and Business Efficiency." Journal of Human Thermodynamics (JHT), Vol. 1, Issue 6 [pgs. 62-67] - Dec (ISSN: 1559-386X) [*human molecule* concepts discussed.] [URL] http://www.humanthermodynamics.com/JHT/Business-Efficiency.html
(f) Maxwell, A. (2005). "Conditioned Response Consciousness." Journal of Human Thermodynamics (JHT), Vol. 1, Issue 2 [pgs. 13-20] – Sep (ISSN: 1559-386X) [*human molecule* concepts discussed.]

[65] Rousseau, Pierre. (2006). "The Constant Flow of Human Molecules." PBase Photography. [URL]: http://www.pbase.com/pierresphotography/image/69620337/large
[66] To review, the formula and concept of a 'human molecule' was derived independently by American limnologists Robert Sterner and James Elser in April of 2000 and by Libb Thims in September of 2002, stemming from an early treatise on *Cessation Thermodynamics*.

9 – Molecular Evolution:

[1] (a) Harrison, G. (1965). *The Role of Science in Our Modern World.* New York: William Morrow, p. 95.
(b) Margulis, L. & Sagan, C. (1995). *What is Life?* (pg. 17). Berkeley: University of California Press.
[2] (a) "The Evolution Debate" (2007). New York Times, April 18,
[URL]: http://www.nytimes.com/pages/science/sciencespecial2/index.html
(b) In 2006 and 2007, the evolution article at Wikipedia was the longest science article, had the most archived talk pages of the science articles, and was one of the most vandalized pages of the science articles; see, for example: Most vandalized articles (Wikipedia);
[URL]: http://en.wikipedia.org/wiki/Most_vandalized_articles; longest articles (Wikipedia);
[URL]: http://en.wikipedia.org/wiki/Special:Longpages
[3] (a) "Did Humans Evolve? Not Us, Say Americans" (2006). *The New York Times*, August 15.
(b) The acceptance of evolution is lower in the United States than in Japan or Europe, largely because of widespread fundamentalism and the politicization of science in the United States. Source: Jon D. Miller, Eugenie C. Scott, Shinji Okamoto. (2006). "Public Acceptance of Evolution." *Science* 11 August: Vol. 313. no. 5788, pp. 765 – 766.
[4] Chaisson, Eric, J. (2001). *Cosmic Evolution – the Rise of Complexity in Nature.* Cambridge, Mass.: Harvard University Press.
[5] Cosmic evolution (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Cosmic_evolution
[6] (a) Ibid, pg. 16.
(b) Eric Chaisson (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Eric_Chaisson
[7] Big Bang (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Big_bang
[8] (a) Continuous stirred-tank reactor (Wikipedia);
[URL]: http://en.wikipedia.org/wiki/Continuous_stirred-tank_reactor
(b) In more detail, each reactor subsystem in the earth, can be modeled as a CSTR in which the integral mass balance on number of moles N_i of species i in a reactor of volume V can be accounted for via the following species balance equation: [accumulation] = [in] - [out] + [generation], which equates to: $dN_i/dt = F_{i0} – F_i + V\nu_i r_i$, where F_{io} is the molar flow rate inlet of species i, F_i the molar flow rate outlet, and ν_i stoichiometric coefficient. The reaction rate, r, can be figured by using the Arrhenius temperature dependence.
(c) Schmidt, Lanny D. (1998). *The Engineering of Chemical Reactions*. New York: Oxford University Press.
[9] (a) Note: BYA = Billion Years Ago, YAB = Years After Bang, MYA = Million Years Ago.
(b) Thims, L. (2006). "Molecular Evolution Table", (calculations and sources). Chicago: Institute of Human Thermodynamics [IoHT], [URL]:
http://www.humanthermodynamics.com/Evolution-Table.html
(c) Thims, L. (2006). "Thermodynamic Evolution", (article). Chicago: Institute of Human Thermodynamic [IoHT], [URL]: http://www.humanthermodynamics.com/Evolution.html
(d) Note: this molecular evolution table was first published Thims 2002 *Human Thermodynamics*, VI.

(e) A more complete molecular evolution table would need to show the main 1,000 or more essential species intermediate between that of the human molecule and the hydrogen molecule, a full table would list them all, possibly numbering in the billions.
(f) Atkins, Peter. (2003). *Atkins' Molecules, 2nd Ed.* Cambridge: Cambridge University Press.
[10] (a) Note: Antiparticles not shown.
(b) Veltman, Martinus. (2003). *Facts and Mysteries in Elementary Particle Physics.* New Jersey: World Scientific.
[11] (a) Thims, L. (2005). "Molecular Evolution", Chicago: Institute of Human Thermodynamics, Dec. 18. [URL]: http://www.humanthermodynamics.com/Evolution.html
(b) Gladyshev, Georgi. (1997). *Thermodynamic Theory of the Evolution of Living Being.* New York: Nova Science Publishers.
(c) Chaisson, Eric, J. (2001). *Cosmic Evolution – the Rise of Complexity in Nature.* Cambridge, Mass.: Harvard University Press.
(d) Haynie, Donald. T. (2001). *Biological Thermodynamics.* Cambridge: Cambridge University Press.
[12] (a) Bonanno, A., Schlattl, H., and Patern, L. (2002). "The age of the Sun and the relativistic corrections in the EOS." *Astronomy and Astrophysics*, Vol 390, pgs. 1115-18. [URL]: http://arxiv.org/PS_cache/astro-ph/pdf/0204/0204331.pdf
(b) Nucleocosmochronology (Wikipedia); [URL] http://en.wikipedia.org/wiki/Nucleocosmochronology
[13] In the expression M_N, N is whole number used to signify a specific species in a series.
[14] Haywood, John. (1997). *Atlas of World History*. New York: Barnes & Noble Books.
[15] Wells, Spencer. (2002). *The Journey of Man – a Genetic Odyssey*. New York: Random House Trade Paperbacks.
[16] Von Baeyer, H.C. (1998). *Warmth Disperses and Time Passes – the History of Heat*. New York: The Modern Library.
[17] Hazen, R.N. (2005). *Genesis – the Scientific Quest for Life's Origin*. Washington: Joseph Henry Press.
[18] Hard science (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Hard_science
Soft science (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Soft_science
[19] More research and discoveries will be needed to determine what occurred before the 13.7 BYA mark in the history of the universe to determine if molecular life is coeternal with matter having no real beginning.
[20] (a) Nucleosynthesis (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Nucleosynthesis
(b) Stellar nucleosynthesis (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Stellar_nucleosynthesis
(c) Supernova nucleosynthesis (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Supernova_nucleosynthesis
(d) Big Bang nucleosynthesis (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Big_Bang_nucleosynthesis
(e) Chemical evolution (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Chemical_evolution
(f) Molecular evolution (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Molecular_evolution
[21] Gauge boson (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Gauge_boson
[22] (a) Dawkins, Richard. (1976). *The Selfish Gene.* Oxford: Oxford University Press.
(b) Gene-centric view of evolution (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Gene-centric_view_of_evolution
(c) The Selfish Gene (Wikipedia); [URL]: http://en.wikipedia.org/wiki/The_Selfish_Gene
(d) Williams, George C. (1966). *Adaptation and Natural Selection: A Critique of Some Current Evolutionary Thought.* Princeton: Princeton University Press.
[23] (a) Levine, Ira. (1983). *Quantum Chemistry, 3rd Ed.* Boston: Allyn and Bacon, Inc.

(b) Alberty, Robert A. (2003). *Thermodynamics of Biochemical Reactions.* New York: John Wiley & Sons, Inc.
(c) Quantum chemistry (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Quantum_chemistry
(d) Chemical thermodynamics (Wikipedia);
[URL]: http://en.wikipedia.org/wiki/Chemical_thermodynamics
(e) Biological thermodynamics (Wikipedia);
[URL]: http://en.wikipedia.org/wiki/Biological_thermodynamics
[24] (a) Nowak, Martin, A. (2006). *Evolutionary Dynamics – Exploring the Equations of Life.* Cambridge, Mass.: The Belknap Press of Harvard University Press.
(b) Hamilton, W. D. (1963) The evolution of altruistic behavior. *The American Naturalist* **97** (896): 354-356.
(c) Hamilton, W. D. (1964) The genetical evolution of social behaviour. *Journal of Theoretical Biology* **7**: 1-52.
(d) W. D. Hamilton (Wikipedia); [URL]: http://en.wikipedia.org/wiki/W._D._Hamilton
[25] Unit of Selection (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Unit_of_selection
[26] Williams, George. (1966). *Adaptation and Natural Selection.* (pgs. 22-23.), Princeton University Press.
[27] (a) Watson, James, D. (2003). *DNA – the Secret of Life.* New York: Alfred A. Knopf.
(b) Margulis, L. & Sagan, C. (1995). *What is Life?* (pg. 7). Berkeley: University of California Press.
[28] Nobel Prize in Physiology or Medicine (1962);
[URL]: http://nobelprize.org/medicine/laureates/1962/index.html
[29] Dawkins, Richard. (1976). *The Selfish Gene*. (pg. 2). New York: Oxford University Press.
[30] Margulis, L. & Sagan, C. (1995). *What is Life?*. Berkeley: University of California Press.
[31] RNA world hypothesis (Wikipedia); [URL]:
http://en.wikipedia.org/wiki/RNA_world_hypothesis
[32] Ridley, Matt. (2003). *The Agile Gene – How Nature Turns on Nurture.* New York: Perennial.
[33] Schlesinger, William, H. (1991). *Biogeochemistry – an Analysis of Global Change.* New York: Academic Press, Inc.
[34] (a) Bazarov, I. (1964). Thermodynamics (textbook). New York: The Macmillan Company.
(b) IoHT's List of: "110+ Variations of the Second Law of Thermodynamics"
[URL]: http://www.humanthermodynamics.com/2nd-Law-Variations.html
(c) History of perpetual motion machines (Wikipedia);
[URL]: http://en.wikipedia.org/wiki/History_of_perpetual_motion_machines
[35] (a) Ur-organism (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Ur-organism
[36] (a) Coacervate (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Coacervate
(b) Oparin, A.I. (2003). *Origin of life* (1st ed. 1938). New York: Dover Publications.
(c) Oparin, Aleksandr (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Aleksandr_Oparin
[37] Last Universal Ancestor (Wikipedia); [URL]:
http://en.wikipedia.org/wiki/Last_universal_ancestor
[38] Martin Rees (general editor), (2005). Universe (encyclopedia), pg. 52. New York: DK Publishing, Inc.
[39] Thims, L. (2006). Query of 30 Americans, aged 18-30, with the question: "When did Life Begin and What Did It Look Like?" Field Research, Chicago [06/09/06].
[ULR]: http://www.humanthermodynamics.com/RP/When-Did-Life-Begin.html
[40] (a) Life (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Life
(b) Non-life (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Non-life
[41] Bacteria (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Bacteria

[42] Helmholtz, Hermann von. (1862). “On the Conservation of Force.” – Introduction to a series of lectures delivered at Carlsruhe in the winter of 1862-63. Kessinger Publishing.
[43] (a) Poincare, A. (1983-reprint). *On Science.* Moscow: Nauka.
(b) For reference on the (approximate) molecular formula for a bumble-bee, see: http://www.humanthermodynamics.com/Evolution-Table.html; i.e. it is commonly known that insects, i.e. anthropods, evolved from some form of worm; as such, in this source, the approximate molecular formula for an aquatic worm is shown allowing the reader to make extrapolation.
[44] (a) *Sebastiano Venturi*, MD (Italy); Selected publications [URL]: http://web.tiscali.it/iodio/
(b) Iodine and evolution [URL]: http://www.iodine4health.com/special/venturi_evolution.htm
[45] (a) Raup, D. & Sepkoski, J. (1982). "Mass extinctions in the marine fossil record". *Science* 215: 1501–1503.
(b) Extinction event (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Extinction_event
[46] (a) Species (Wikipedia); [URL]: http://en.wikipedia.org/wiki/Species
(b) Species (table); [URL]: http://www.redlist.org/info/tables/table1
[47] Bacteria (article). Ohio State University;
[URL]: http://www.mansfield.ohio-state.edu/~sabedon/biol3015.htm
[48] DMOZ – Open Directory (2006). “Chemical Databases”.
[URL]: http://dmoz.org/Science/Chemistry/Chemical_Databases/
[49] (a) Gladyshev, G.P. (1978). “On the Thermodynamics of Biological Evolution.” *Journal of Theoretical Biology, Vol. 75, Issue 4, Pgs. 425-41.*
[URL]: http://www.sciencedirect.com/science/journal/00225193

Photo Credits

(1) Geoffroy’s 1718 Affinity Table (public domain); found in Libb Thims’ 2007 *Human Chemistry (Volume Two),* pg. 382.
(2) Mendeleyev’s 1869 Periodic Table (public domain); found in Paul Strathern’s 2000 *Mendeleyev’s Dream – The Quest for the Elements*, pg. 287.
(3) Modern Periodic Table (designed by Thims).
(4) Benard’s cell (diagram); U.S. Gov. Earth Systems Research Laboratory; public domain.
[URL]: http://www.etl.noaa.gov/about/eo/science/convection/RBCells.jpg
(5) 3 Atoms (Animation Factory); 1-year membership = 99.95, Nov 2005 – Oct 2006, Royalty Free, [URL]: www.animationfactory.com
(6) Advanced Intelligence Diagram (made by Libb Thims); using images self-made, from Animation Factory, and from the following GNU FDL image created for Wikipedia by lucidish: [URL]: http://en.wikipedia.org/wiki/Image:Soc_psy_relation.gif
(7) Acetic acid (graphic); public domain; made by: Wikipedian Benjah-bmm27 on 23 May 07;
[URL]: http://en.wikipedia.org/wiki/Image:Acetic-acid-3D-balls.png
(8) Guy spinning on head (Animation Factory); 1-year membership = 99.95, Nov 2005 – Oct 2006, Royalty Free, [URL]: www.animationfactory.com
(9) Protein molecule (3D image of myoglobin) (public domain); Image created by en:User:Magnus Manske from PDB file. Source: Sperm whale (Physeter catodon); Authors: S.E.V. Phillips; Reference: "Structure and refinement of oxymyoglobin at 1.6 Å resolution.", J. Mol. Biol. 1980, 142, 531.; [URL]: http://en.wikipedia.org/wiki/Image:Myoglobin.png
(10) Caffeine Molecule (Animation Factory); 1-year membership = 99.95, Nov 2005 – Oct 2006, Royalty Free, [URL]: www.animationfactory.com
(11) Earth Molecule (Animation Factory); 1-year membership = 99.95, Nov 2005 – Oct 2006, Royalty Free, [URL]: www.animationfactory.com
(12) Sun Molecule (Animation Factory); 1-year membership = 99.95, Nov 2005 – Oct 2006, Royalty Free, [URL]: www.animationfactory.com
(13) Male/Female/Earth molecule bonding diagram (made by Libb Thims).
(14) Retinal molecule (GNU FDL); made by Wikipedian V8rik; date: 22 Sep 06.

[URL]: http://en.wikipedia.org/wiki/Image:RetinalCisandTrans.png
(15) Walking Molecule (image); Author = Ludwig Bartels, First Published in Physics Review Letters Oct 2005. Used with permission. Image also found here:
Pittalwala, M. (2005). "Molecule Walks Like a Human", Sept., Source: UCR Newsroom, Sept. 26; [URL]: http://www.newsroom.ucr.edu/cgi-bin/display.cgi?id=1166
(16) Graph: Are you a Giant Molecule (made by Libb Thims); using data as collected by a 2001 – 2008 Poll by Jim Eadon; [URL]: http://www.eadon.com/phil/humanchemical.php
(17) The Constant flow of human molecules (picture); photo by Pierre Rousseau. Date: Nov, 02, 2006. Location: Austin Texas. *Nikon D70 ,Nikkor 55mm f/3.5 Micro* Used with permission. [URL]: http://www.pbase.com/pierresphotography/image/69620337/large
(18) Bacteria Molecule (public domain); from the *Agricultural Research Service,* the research agency of the *United States Department of Agriculture.* Image found here:
[URL]: http://en.wikipedia.org/wiki/Image:E_coli_at_10000x.jpg

Index:

8

80-20 rule, 18

A

activation energy, 24, 28
Adams, Henry, 21, 22, 59, 91, 92
advanced intelligence perspective, 39, 40, 41
  human super-observer, 20, 41
  unsuspected visitor perspective, 42
affinity, 3, 4, 5, 12, 16, 91
  double elective affinity, 5
affinity table, 4
alpha male, 79
ambivalence, 74
Aristotle, 2, 75
atom
  atomic society, 7
  combined atoms, 5
atoms, 1, 2, 3, 5, 22, 34, 39, 41, 42, 43, 51, 58, 60, 61, 66, 71, 74, 75, 77, 78, 79, 80, 83, 86, 97, 98
attraction, 46, 47
automaton, 2, 3
Avogadro, Amedeo, 5, 22
Avogadro's number, 22

B

Ball, Philip, 32, 63, 90, 91, 93, 94
Bartels, Ludwig, 63
Bazargan, Mehdi, 60, 98
Bearman, Peter, 67
Bénard's cell formation, 34
Bénard's cells, 34
Bergman, Torbern, 4
Bergson, Henry, 23
Berzelius, Jöns, 13
Big Bang, 100, 101
biogeochemical molecule, 57
biological evolution, 96, 99
Biological Thermodynamics, 101
Bohr, Niels, 87
Boltzmann, Ludwig, 65, 92
Boltzmann, Ludwig von, 8, 9, 31, 38, 90, 94
bonding affinities, 16
bonding brackets, 4
bonding sites, 59
boson, 70, 76, 86, 101
Boutmy, Emile, 12, 13, 91
Boyle, Robert, 3, 87
Boyle's law, 29, 30
Boyle-Charles law, 7
Brownian motion, 22
Buchanan, Mark, 38
Buckle, Henry, 8, 9, 10

C

Campbell, Arthur, 91
Carey, George, 12, 13, 14, 16, 17, 68
Carnot, Lazare, 36
Carnot, Sadi, 36, 45, 93
catalyst, 15, 65
  human catalyst, 15
catalytic closure, 80
Cessation Thermodynamics, 50, 96, 99, 100
Chaisson, Eric, 69, 100
chaos, 16
chemical affinity, 4, 46
chemical equation, 66
chemical evolution
  gradual chemical evolution, 73
chemical gravitation, 58
chemical reaction, 41, 72, 74, 75, 81, 85, 86, 87, 97
  combination reaction, 79
chemical reaction mechanism, 73
chemical species, 39, 51, 66, 78, 83, 85, 86
chemical thermodynamics, 17, 50, 52, 55, 56, 62, 76
Chemistry of Human Life, 16
Chen, Jing, 65
classical thermodynamics, 44, 45
Clausius, Rudolf, 15, 36, 37, 45, 87, 92, 93
clay

composition of human, 1, 2, 65
climax ecosystem level, 37
combined law of thermodynamics, 46
complexity, 39, 41, 80, 81, 82, 84
conservative dynamical system, 29
Crick, Francis, 77
CSTR, 69, 100
Cullen, William, 4

D

da Vinci, Leonardo, 2
Dalton, John, 5
Darwin, Charles, 9, 21, 29, 64, 65, 73, 77, 79, 81, 87, 92
Darwin, Charles Galton, 28, 29, 30, 59, 60
Davy, Humphry, 5
Dawkins, Richard, 77
DeMarco, Tom, 37
derivations, 19
Descartes, Rene, 2, 3, 68, 77
Diamond, Jared, 63
dihumanide bond, 47
dihumanide molecule, 62
Di-human-ide molecule, 68
dispersion forces, 45, 47
dissipation, 34, 35, 36, 37
dissipative structure, 34, 36, 37, 38
DNA, 42, 70, 71, 76, 77, 78, 83, 84, 102
dopamine, 71
dynamical theory of heat, 36
dynamics, 34, 41, 59, 63, 78

E

E. coli bacteria, **83**
Eadon, Jim, 64, 104
earth molecule, 58, 59
ecological stoichiometry, 49
economics, 42
Edgeworth, Francis, 11, 91
efficiency, 15, 36
Einstein, Albert, 22, 97
Elective Affinities, 5, 91
elective affinity, 4
electromagnetic force, 46, 47
electromagnetic potentials, 45
element, vii, 1, 5, 13, 14, 16, 37, 50, 51, 52, 57, 58, 60, 61, 65, 66, 68, 69, 71, 72, 76, 78, 80, 84, 85, 86
Elser, James, vii, 48, 49, 50, 51, 65, 89, 95, 96, 100
empirical formula, 43
energy
  kinetic energy, 75
entropy, 15, 35, 36, 37, 55, 94
  negative entropy, 77
  personal entropy, 15, 16
  Social Entropy, 42
equilibrium, 37, 58, 87
  far-from-equilibrium, 35
  general equilibrium point, 11
  market equilibrium (human atoms), 31
  state of equilibrium (society), 20
  ultimate equilibrium (society), 21
evolution, 35, 37, 69, 75, 77, 78, 79, 81, 82, 83, 84, 85, 87, 100, 101, 102, 103
  cosmic evolution, 69
  cultural evolution, 9
  human molecular evolution, 56
  molecular evolution, 56, 71, 78, 84, 85
  planetary chemical evolution, 69
evolution lineage, 72
evolution potential, 37
evolution reaction, 73
exchange
  mutually favorable exchange, 34
exchange value, 34
external work, 15

F

Fairburn, William, 14, 15, 16, 65, 91
fall in love, 34
fermions, 71, 86
Forbes, Allan, i, 89
four humours, 2
free electrons, 37
free energy, 79, 87
free will, 30
Free will, 59
free-will, 38
Fromm, Eric, 33, 34, 49
Fuller, Steve, 63
Fundamental Principles of Equilibrium and Movement, 36
future, 23, 25, 26, 27, 28, 29, 30, 42

G

Galileo, 23

Gallagher, Laura, 48
gas molecules
swarm of bees (analogy), 10
Gassendi, Pierre, 3
gauge bosons, 71
genotypes, 77
Geoffroy, Etienne, 3, 4
Gibbs free energy, 37, 46, 50, 55, 79, 87
Gibbs, Willard, 17, 29, 45, 92
Gladwell, Malcolm, 38
Gladyshev, Georgi, 37, 51, 96, 97
Gladyshev, Georgi P., 37, 65, 87, 93, 96, 97, 99, 101, 103
Goethe, Johann von, 5, 7, 50, 56, 59, 60
Gottman stability ratio, 46
Granit, Ragnar, 61
Groot, S. R. de, 9
guest, 59, 97, 99
Guttenberg, Johannes, 2

H

Hall, Edward, 91
Hamilton's fractional gene theory, 76
Hartline, Haldan Keffer, 61
hate, 26, 27, 44, 47
Hazen, Robert, 65, 81, 82, 101
heat, 16, 34, 36, 37, 63, 73, 75, 77, 79
Hegel, 5
Heilbroner, Robert, 31, 32, 93
Helmholtz, Hermann von, 56, 84, 97, 103
Henderson, Lawrence, 20, 91
Hippocrates, 2
Hobbes, Thomas, 3, 31
Hooker, Joseph, 73
host, 59
human
'a kind of molecule', 17
Human, **70**
human 'elective affinities', 56
human atom, 33
human behavior, 63
ideal gas model, 38
human body
Teilhard's estimate of atoms in, 24
human body elemental mass composition tables, **43**
human chemical bond, 12, 26, 34
human chemical bonds
genetic-potential sexual chemical bonds, 67
human chemical elements, 16
human chemical reaction, 15, 37, 52, 66
human chemicals, 14, 16
human chemistry, 39, 52, 64, 65, 86, 99
Human Chemistry, iv, vii, 14, 50, 89, 90, 91, 92, 93, 95, 96, 98, 103
human molecular formula, 68
stoichiometric formula, **48**
Human molecular symbols, 66
human molecule, vii, 5, 6, 11, 12, 13, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 36, 37, 38, 42, 44, 49, 50, 51, 52, 56, 57, 58, 59, 60, 61, 62, 64, 65, 66, 67, 68, 70, 76, 86, 87, 96, 97, 98, 99, 100, 101, 104
26-element molecule, 48, 50
free electrons, 37
giant molecule (poll), 64
human chemical, 14
human electrons, 38
I Am Not a Molecule, 63
Molecule Walks Like a Human, 63
point atom, 5
social molecule, 6, 7
structural molecule, 37
walking-molecule, 63
well formed molecules, 62
Human molecule, 51
human motor, 16
human organism
table of views, 64
human particles
conscious choice (paradox), 31
human reaction 'free energies', 56
human species, 85
human systems, 30
Human Thermodynamics, 50, 51, 89, 92, 94, 95, 96, 97, 98, 99, 100
human web, 42
humans
complicated molecules, 30
humans (bonded)
compounds, 62
Huxley, Thomas, 6, 7, 90
Hwang, David, 62, 66, 98, 99

I

id, 98, 104
Infante, Alfredo, 42
Institute *of* Human Thermodynamics, 96, 100, 101

Interaction, 40
interactions, 41, 44, 45, 46, 47, 48
  electromagnetic interactions, 41
  energy interactions, 81
  fundamental interactions, 40
  human interactions, 41
  sensory interactions, 42
  webs of interactions, 42
interfacial-tension, 47
interhuman potential, 46, 47
intermolecular force, 45
intermolecular racism, 47
internal energy, 29, 36, 87
irreversible, 36
isomerization reaction, 79

J

Joule, James, 45
Joyce, Gerald, 82

K

Kant, 68
Kármán line, 72
Kauffman, Stuart, 80
Kauffmann, Stuart, 80
Kelvin, Lord. See William Thomson

L

law of chemical operation, 16
law of universal gravitation, 29, 97
laws of affinity, 4
laws of chemical affinity, 16
laws of chemistry, 51, 76, 87
laws of science, 52
laws of statistical thermodynamics, 29
laws of thermodynamics, 21, 37, 71, 79
Leucippus, 2, 3
life
  anthropomorphic-view, 69
  atomic life, 76, 84, 86
  chemical life, 78
  earth life, 71
  galactic life, 86
  human life, 29, 34, 37, 38, 39, 40, 41, 69
  human molecular life, 59
  meaning of life, 76
  non-life, 79, 82, 83
  quark life, 86
  secret of life (DNA), 77
  spark day, 79
  Teilhard's definition, 28
  thrill of life, 34
  When did life begin and what did it look like?, 83
Lister, Timothy, 37
living systems, 35
love, 11, 12, 23, 27, 34, 44, 47
Lovelock, James, 65, 94
Lurquin, Paul, 81

M

macroscope, 41, 86
Margulis, Lynn, 79
mate recognition system, 39
mating market, 34
matter
  animate vs. inanimate, 25
Maxwell, James, 8, 9, 10, 22, 31, 61, 90, 92, 93, 97, 99
McNeill, J. R., 42
McNeill, William, 42
mechanical energy, 36
Mendeleyev, Dmitri, 13
minimum of free energy, 37
minority molecules, 47
moleculacentric, 39
molecular evolution table, **70**, 74, 84, 86
molecular formula, 43
  human, 1
molecular ghetto, 47
molecular orbital theory, 38
molecular species, 72, 80, 85, 87
molecule
  etymology, 3
Molecule, 39
molecule carrier, 63
Molecule Man, 62
Moody, James, 67
Moreno, Jacob, 32, 33, 93
Müller stability ratios, 46
Müller, Erich, 44, 45, 46, 47, 48
Müller's human molecules, 44
Mumford, Lewis, 31, 93

N

Neumann, John von, 65

Newton, Isaac, 3, 5, 29, 46, 89, 97
noosphere, 26, 27
nuclear fusion, 71

O

On a Universal Tendency in Nature to the Dissipation of Mechanical Energy, 36, 93
On the Thermodynamics of Biological Evolution, 93, 103
Oparin, Aleksandr, 73, 74, 81, 102
order
  arrangement, 39, 42, 79
origin of life, 73, 75, 81, 83
  coacervate droplet, 74
  initial source of energy, 75
  primeval soup, 74
  progenitor, 81, 82
  RNA world hypothesis, 78
  spontaneous generation theories, 75
  standard views, 75
  ur-organism, 81

P

Pareto principle, 18
Pareto, Vilfredo, 17, 18, 19, 20, 38, 41, 62, 65, 91, 94
particle physics, 52
people
  economic molecules, 11, 17, 62
  human aggregates, 31
  human atoms, 12, 34, 38
  varied elements, 12
Peopleware, 37
periodic table, 13, 14
Perrin, Jean, 22, 92
person
  human chemical element, 14
  human element, 26
phase space, 37
phenotypes, 77
photon, 85
Pinker, Steven, 63
Planck, Max, 87
Planetary-sized molecules, 57
plankton ecology, 49
Plato, 4
Poincare, Antoni, 84
point attractor, 37
Poitevin, B., 37
political bonds, 45
potential, 37
pressure, 29, 34
Prigogine, Ilya, 34, 35, 36, 65, 93
Proton-proton chain reactions, 56
psychodynamics, 27

Q

quantum chemistry, 76
quantum electrodynamics, 52
quark, 40, 75, 76

R

reaction arrows, 4
reaction mechanism, 72, 75
reaction rate, 84, 100
  species formation, 85
receptor, 59
Redi, Francesco, 75
Reiser, Oliver, 20, 41, 91, 94
Related or cultural human molecular views, 62
relationship webs, 42
Remer, Rory, 33, 93
repulsion, 46, 47
residues, 19
retinal molecule, 60, 61
reversible, 36
Rift valley Homo sapiens, 73
Rosnay, Joel de, 41, 94
Rousseau, Pierre, 68, 104

S

Sagan, Dorian, 79
Schiller, Ferdinand, 11, 12, 91
Schrödinger, Erwin, 77
second law of thermodynamics, 21, 22, 35, 36, 42
selfish gene theory, 76, 77, 78
selfish molecule, 76
serotonin, 79
sexual relationship ring, 67
sexual social cluster, 67
social aggregations, 46
social atom, 32, 33
social atom theory, 32, 33
social chemistry, 6, 7
social class, 46

social forces, 44, 45, 47
social organism, 19
sociometry, 32
solar system, 40, 87
solar thermodynamic cycles, 37
solidness of a society, 45
Spencer, Herbert, 101
Spinoza, 5
Spinoza, Benedict de, 60
spontaneity, 34, 75, 79
stability, 67, 79
Stark, Werner, 7, 90
statistical thermodynamics, 8, 44
Sterner and Elser's empirical human molecular formula, 48
Sterner, Robert, vii, 48, 49, 50, 51, 65, 89, 95, 96, 100
Stovel, Katherine, 67
structural formula, 43
struggle
  there is no struggle, **74**
  vs. react, 74
substrate, 51, 65, 77
Substrate, 65
sun's current age, 71
supermolecular evolution, 37
supermolecule, 56
supramolecular chemistry, 52
symbiotic relationships, 47

T

Taine, Hippolyte, vii, 5, 6, 65, 68, 89, 90
Teilhard, Pierre (de Chardin), 23, 24, 25, 26, 27, 28, 41, 65, 92
The Art of Loving, 33
The Next Million Years, 28, 29, 92
The Origin of Life, 74
The Selfish Gene, 77, 101, 102
The Social Atom, 38
The Thermodynamics of Love, 66, 99
thermo-dynamic, 36
thermodynamic potentials, 44
thermodynamic system
  molecular system, 81
thermodynamic tables, **55**
thermodynamics, 35, 69, 79, 87, 92, 97, 102
thermonuclear molecule, 58
thermonuclear reactions, 58
Thims, libb, iv, 50, 89, 92, 93, 95, 96, 97, 98, 99, 100, 101, 102
Thims, Libb, iv, 103, 104
Thims' human molecules, 50
Thomson, William, 21, 36
tipping point, 77
tipping points, 38
total energy, 29, 37
transformation of energy, 36
transformation-energy, 36, 37
true happiness, 15

U

unified theory of evolution, 87
universe, 39, 40, 42, 68, 69, 71, 74, 75, 76, 81, 83, 101

V

valence electrons
  outer electrons, 98
van der Waals dispersion force, 44
Venturi, Sebastiano, 84, 103
Vitruvian Man, 2
Vitruvius, Marcus, 2
volume, 29, 87, 100

W

Wald, George, 61
Walras, Auguste, 11
Walras, Léon, 11, 17, 19, 62, 91
warm little pond, 73
wasteful reaction, 15
Watson, James, 77
What is Life?, 74, 77, 79, 95, 100, 102
Williams, George, 76
work
  useful work, 36, 37
work orbitals, 37
working system, 36

X

xy-element molecules, 43